

THE HYMENOPTEROUS PARASITES OF LEAF-FEEDING APPLE TORTRICIDS (LEPIDOPTERA, TORTRICIDAE) IN THE NETHERLANDS

by

H. H. EVENHUIS and H. J. VLUG

Research Institute for Plant Protection (I.P.O.), Wageningen, The Netherlands

ABSTRACT

Fifty-six Hymenopterous parasites, reared from apple leafroller caterpillars and pupae in the Netherlands, are listed. Brief descriptions and a key are given to separate related parasite species. The great difficulties encountered in discriminating between narrowly related, insufficiently described species are discussed. These difficulties in most cases make it impossible to obtain reliable species names. Data about host specificity are given because identification of host caterpillars and pupae now became possible. Knowledge of host specificity is considered an essential and often indispensable aid in species discrimination.

INTRODUCTION

In the Netherlands leafroller caterpillars belong to the most important apple pests. In particular *Adoxophyes orana* is harmful, though caterpillars of *Archips rosana*, *A. podana*, *Pandemis heparana*, *P. cerasana*, *Spilonota ocellana* and *Hedya nubiferana* may also cause considerable damage to the fruits.

The role that natural enemies play in controlling apple leafrollers is appreciated in quite different ways. Whereas Janssen (1958) does not consider the parasites of *Adoxophyes orana* essentially important in Western Germany, Auersch (1960) states that they contribute to a considerable reduction of its host numbers in the same region.

In connection with investigations on integrated control in apple growing, it was necessary to study the parasites of apple leafrollers. This means in the first place an inventory of the several parasites, together with investigations on the relationships with their hosts, and estimates of their importance as mortality factors of the leafrollers.

A number of papers concerning the parasite fauna of apple leafrollers in Europe have been published, viz., by Lehmann (1969), Papp & Reichart (1973), Carl (1974), Charles (1974), Evenhuis (1974a, b) and Miczulski & Kořlinská (1976) for the D.D.R., Hungary, Switzerland, France, the Netherlands and Poland, respectively. These regions have many species in common, but also show differences. This may be largely caused by different identifications for one and the same species.

There is an urgent need for a reliable species identification of both parasites and hosts. It is a prerequisite to study their interrelationships and to compare the results with other regions. We will discuss these matters in the next chapters.

METHODS

Leafroller caterpillars and pupae were collected from apple in various orchards in the Netherlands from 1970 onwards. Each specimen was separately kept in a glass vial under outdoor conditions and the caterpillars were provided with an artificial diet as recommended by Ankersmit (1968). They were inspected three times a week.

The emerging adult insects were either leafroller moths or Hymenopterous or Dipterous parasites. The Hymenoptera were glued on a triangular card board. The host caterpillar remains with the parasite cocoon were glued on a separate card board on the same pin. We took care to show the inner sides of the caterpillar mandibles, as these present important characters (Evenhuis & Vlug, 1972). Egg parasites are excluded from this study.

IDENTIFICATION OF THE HOST

Though identifying adult Dutch Tortricidae does not give too much trouble, thanks to the works of Hannemann (1961), Bentinck & Diakonoff (1968) and Bradley et al. (1973), identification of the caterpillars and pupae is much more of a problem. The older living instars of the apple leafroller caterpillars may be identified with the key of De Jong & Vlug

(1974), based on superficial characters, particularly colours. Swatschek (1958) in his keys of last-instar caterpillars of Central European leaf-rollers mainly used the position of the chetae on thorax and abdomen as differentiating characters (chaetotaxy). However, after a parasite has emerged and the host caterpillar has died, the less sclerotized parts of the body appear too much shrivelled and discoloured to make a reliable identification possible.

We have been looking for characters that would better suit our particular needs. We consider the shape of the teeth of the retinaculum in the last three instar caterpillars of Tortricidae Tortricinae important in this respect (Evenhuis & Vlug, 1972). This character, however, seems to hold only for the identification of the genera. Thus genera with only one species occurring on apple, e.g., the most important *Adoxophyes orana*, do not give particular difficulties. In genera with two or more species on apple, these species may be often distinguished by colour differences in the more sclerotized parts as head and pronotum. The caterpillars of the three species of Tortricidae Olethreutinae occurring on apple, viz., *Spilonota ocellana*, *Rhopobota naevana* and *Hedya nubiferana*, are in the older instars, even in a shrivelled condition, generally sufficiently characteristic to be recognized.

Though we were not able to distinguish between the leafroller species in the first and second larval instars, this is hardly necessary as, till yet, we only reared parasites from the older instars.

As to the retinacular teeth we may state now that this character has turned out to be more useful than we suggested in our 1972 publication. Abrasion of the teeth seems only an exception.

A number of parasites emerged from leafroller pupae. Identification of pupae gives less problems than that of the caterpillars. A key for the Dutch species has been published (Evenhuis, De Jong & Vlug, 1973).

IDENTIFICATION OF PARASITIC HYMENOPTERA

The present paper is an attempt to name the Hymenoptera species that we reared from apple leafrollers. When possible, specialists were consulted; for the rest we tried to find out names ourselves. These names, of course, remain doubtful as long as the groups to which the species in question belong, have not yet adequately been revised.

Descriptions are given in which attention is

paid to the characters we consider important for species discrimination, especially in those species about the identity of which we are in doubt. We tried to find new morphological characters. When closely related species for comparison were lacking, we assumed that certain morphological structures might represent good characters. We hope then that during a later revision of the taxonomical groups in question the identity of those species might be established.

For the several species a discussion on host specificity and the period of emergence of adults according to our investigations are given. In table 1 data about host ranges are represented.

The drawings were made by the junior author.

Family ICHNEUMONIDAE

In Europe this may be the largest insect family. Perkins (1959) estimates the number of British species at 2000. The number of Dutch species is estimated to be of the same order of magnitude (Van Achterberg, 1982).

In the sequence of subfamilies, tribus and genera, as well as for the taxonomic terminology, we follow Townes (1969—1971), with some necessary alterations in the names.

Subfamily PIMPLINAE (= Ephialtinae, sensu Townes, 1969)

Scambus brevicornis (Gravenhorst) (figs. 1—4)

Colour characters. — Female. Head black, except for maxillar and labial palps which are yellowish; antenna dark brown. Thorax black, tegula yellowish white, coxae and legs light brown, middle tibia sometimes with subproximal dark ring or spot; hind tibia whitish, subproximally and distally with dark ring; hind tarsus whitish, with distally darkened segments. Abdomen black.

Male. Differs from female in having scape and pedicel whitish yellow below. Fore and middle coxae whitish yellow, rest of fore and middle legs yellow, the latter without dark tibial ring or spot; hind coxa for the most part black, hind trochanter yellow. The smaller males are on the whole somewhat lighter.

Morphological characters. — Female. Clypeus membranaceous and excavated (fig. 1). Prothorax smooth, shiny; mesoscutum and scutellum finely punctate and pilose; remainder of thorax more strongly pilose; propodeum with two incomplete longitudinal carinae, sparsely pilose in front outside the carinae, laterally longer and more densely pilose. Fore wing with small, rhombic areolet; hind wing with nervellus broken beneath the middle (fig. 2). First tergite with two distally converging carinae, area be-

tween them smooth in front, shiny, remainder roughly punctate and somewhat transversely wrinkled; remaining tergites rather strongly punctate, except for the narrow hind parts of segments 2, 3, 4, and 5, which are finely striated transversely (fig. 3); ovipositor two times the length of hind tibia, lanceolate and serrate ventrally near tip (fig. 4).

Male. Smaller and narrower than female. Carinae of propodeum sometimes extending to hind border. Narrow hind parts of tergites smoother, almost without transverse wrinkles.

Length female: 5—7 mm, ovipositor: 3—4 mm, length male: 3.5—5.5 mm.

The genus *Scambus* has not been revised in a modern way and this makes species identification doubtful. We use the name *brevicornis* because its description, together with Schmiedeknecht's interpretation (1914), apparently is closest to it. How intricate matters are, may be inferred from Schmiedeknecht's remark (1914): "Die Gruppe der P. [*Pimpla*, in which *Scambus* at that time was incorporated] *brevicornis* ist die schwierigste der ganzen Gattung. Wir stossen hier auf eine ganze Reihe in Habitus und in der Färbung verschiedener Formen, deren Abgrenzung als Art oder Varietät unübersteigliche Schwierigkeiten bereitet. Ich glaube nicht einmal, dass sorgfältige Zuchtversuche viel Klärung beiträgen würden, denn wollten wir die aus den einzelnen Wirten gezüchteten Formen als besondere Arten auffassen, wo wäre dann das Ende".

We quote Schmiedeknecht's opinion especially because of his misuse of the species concept. A species has to be considered a reproductive community. Only this species concept may be handled in ecological investigations, like that of apple leafroller parasites. As time-consuming cross breeding experiments cannot be easily performed, taxonomists have to rely upon morphological and colour characters from which they usually do not know the variation limits. In contrast to Schmiedeknecht's view, we think that rearing parasites from well-known hosts is always a great help in fixing this variability.

Oehlke (1965) reports *Scambus brevicornis* to be reared from the sawfly *Neodiprion sertifer*; he further mentions the species as a primary parasite of several Microlepidoptera, Diptera and of *Anthonomus pomorum* (Coleoptera). If these records are indeed reliable, *Scambus brevicornis* might be considered pantophagous.

"*Scambus brevicornis*" in our investigations was reared in large numbers as a solitary ectoparasite of second generation *Adoxophyes orana* caterpillars in well-kept orchards. However, the

first instar parasite larva seems to live endoparasitically; the larval moult may be seen protruding from the caterpillar skin. It was observed together with the gregarious ectoparasitic larvae of *Colpoclypeus florus*, which is much more common. The parasite larvae feed on dead caterpillars, just like those of *C. florus*. We do not know if any ecological relation between the two parasite species exists.

Adults: 24 July—28 September. A single specimen appeared on 24 April next spring.

Itopectis alternans (Gravenhorst)

(figs. 5, 6)

Colour characters. — Female and male. Black. Antenna brownish beneath, maxillar and labial palps light brown. Legs predominantly brown, coxae black, hind tibia light and dark brown with a white subbasal ring, tarsal segments of hind leg dark brown, proximally white except for the short fourth one; all claws dark.

Morphological characters. — Female and male. Body for the greater part pubescent. Antenna long, extending far beyond middle of abdomen; inner margin of eye distinctly excavated above the middle, face finely and widely punctate, with short, thin hairs (fig. 5). Mesoscutum rather finely punctate, covered with short, fine hairs, distance between punctures much larger than their diameters; propodeum with two incomplete longitudinal carinae, shiny, bare, except for the pubescent outer front corners. Fore wing with small, rhombic areolet; hind wing with nervellus broken considerably above the middle (fig. 6). Tergites roughly punctate, first smooth between the two lateral carinae in front; tergites 6 and especially 7 more finely punctate than the preceding ones.

Length female: 4.5—7.5 mm, ovipositor: 1—1.5 mm, length male: 2.5—8 mm.

We reared this species as a primary parasite from the pupae of several leafroller species and as a secondary parasite from cocoons of other leafroller parasites. It is known as a primary parasite of the pupae of Lepidoptera belonging to several families and also as a hyperparasite of Lepidoptera through other primary Hymenopterous parasites. Perkins (1957) mentions seasonal dimorphism in the male that we could not confirm.

Adults: 15 August—16 September.

Itopectis maculator (Fabricius)

(fig. 7)

Morphological and colour characters. — This species resembles the former in many respects. Differences are given by Perkins (1941). The hairs on head and thorax are longer and the punctuation is stronger. This is especially shown on the face (fig. 7) and the

middle of the mesoscutum; on the latter the diameter of the punctures is about equal to the distance between these punctures, whereas in the preceding species this distance is much larger. There are also a number of colour differences, the hind borders of the middle tergites and in the female also the lateral borders being brownish.

Length female: 5.5–9 mm, ovipositor: 1.5–2.5 mm, length male: 5.5–7.5 mm.

Though we reared this species in somewhat smaller numbers than the preceding one, it does not seem to be a rare parasite of apple leafroller pupae. We reared it from *Pandemis heparana*, *Adoxophyes orana*, *Archips rosana* and *Hedya nubiferana*. We also reared it from a parasite cocoon, probably *Meteorus ictericus*, on apple; the leafroller remains were lost, however.

Adults: 21 August–1 October. One specimen appeared on 18 July.

Apechthis spp.

(figs. 8, 9)

We reared only a few specimens, belonging to three species of this genus, from apple leafroller pupae. Just like in the related genus *Itopectis*, the inner margin of the eye is distinctly excavated (fig. 8). However, in contrast with this genus, the head shows distinct yellow markings and the ovipositor is bent downwards (fig. 9).

With the keys of Perkins (1941) and Kasparian (1973) the species could be identified as *Apechthis compunctor* (L.), *A. quadridentatus* (Thomson) (= *A. resinator* Thunberg), and *A. rufatus* (Gmelin). Our rearings yielded one male of *A. compunctor* from *Hedya nubiferana* (collected as pupa on 24 June), one female of *A. quadridentatus* from *Pandemis heparana* (adult on 3 August), and two males of *A. rufatus* from *Archips rosana* and *Ptycholoma lecheana*, respectively (adults on 29 and 30 June).

Considering the small numbers reared, it is of no use going into further details.

Subfamily TRYPHONINAE

Phytodietus segmentator (Gravenhorst)

(figs. 10, 11)

Colour characters. — Female. Black, with small, yellow markings above, especially on scutellum, post-scutellum and propodeum. Antenna brownish, above proximally black. Legs predominantly rufous. Hind borders of tergites to a varying extent yellowish.

Male. Yellow, above for the most part black, with rather extensive yellow markings. Antenna and legs as in female. Hind borders of tergites yellowish.

Morphological characters. — Female and male. See

figures of fore tarsal claw (fig. 10) and of wings (fig. 11).

Length female: 4.5–7 mm, ovipositor: 1.5–2.5 mm, length male: 5.5–7.5 mm.

We reared only a few specimens, from a number of localities, exclusively from larvae of *Archips*, both *Archips podana* and *A. rosana*. This species is recorded as a well-known parasite of *Tortrix viridana*. Horstmann (1971) reared it from *Archips xylosteana*, *A. rosana*, *Eudemis porphyra* and in autumn from *Ancylistis mitterbachiana* on oaks. Bogenschütz (1965) considers it an oligophagous parasite of Tortricidae. Horstmann regards it to be plurivoltine.

Adults: 29 June–5 July.

Subfamily CRYPTINAE (= Gelinae, sensu Townes, 1969)

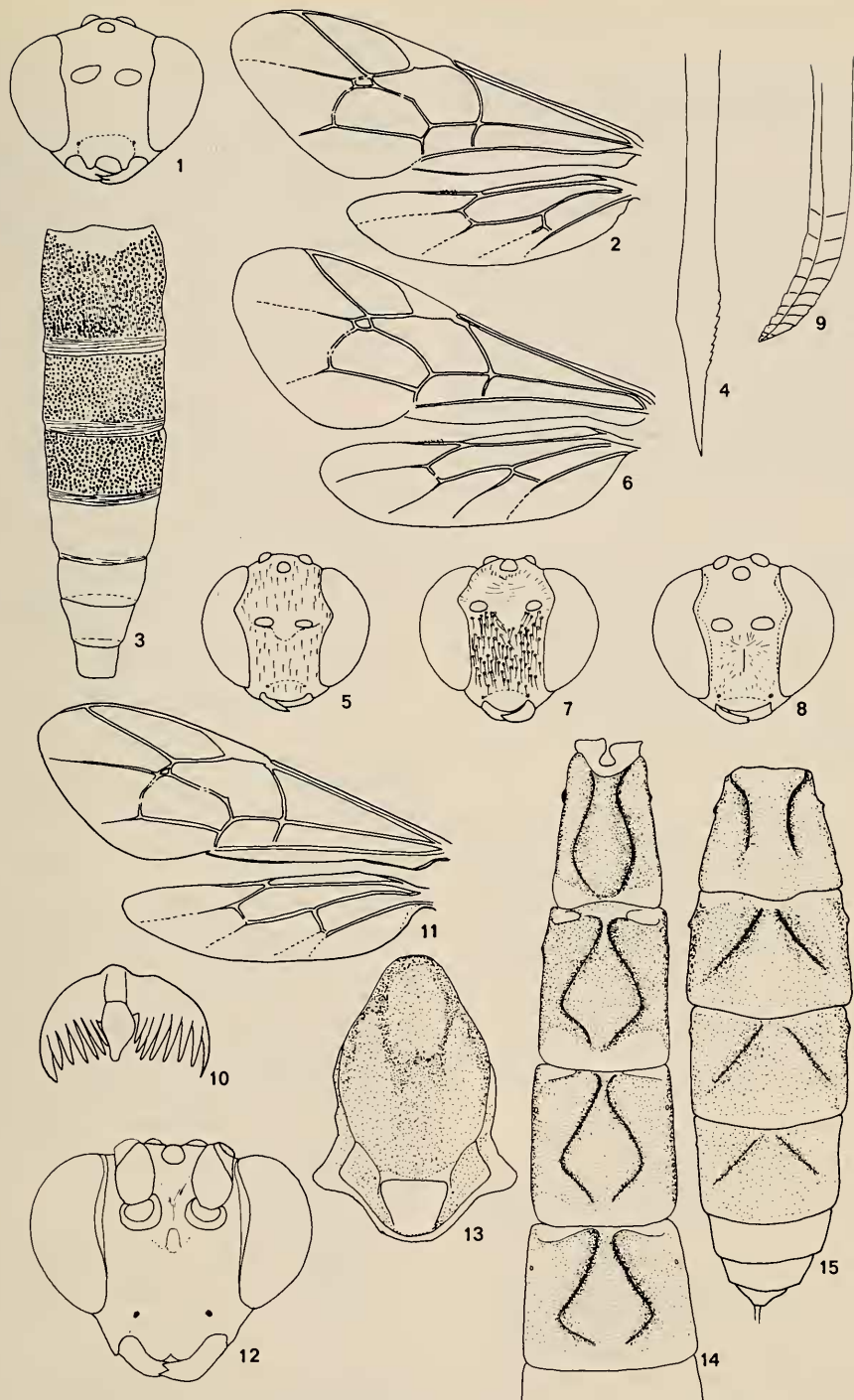
Members of this in taxonomic respect often so difficult subfamily were reared from apple leafrollers as hyperparasites in only very small numbers. They do not seem to play an important role in the natural control of apple leafrollers. Therefore we will only mention them without going into details.

We reared four specimens of *Gelis* sp., three from cocoons of Porizontinae, two of these from *Archips rosana*, and one probably from *Spilonota ocellana* as indirect hosts; one specimen was reared from a pupa of *Adoxophyes orana*. Furthermore, one specimen of *Acrolyta* sp. was obtained from *Spilonota ocellana* through some unidentified Braconid as a direct host, and a few specimens of *Lysibia nana* (Gravenhorst) from cocoons of the gregarious *Apanteles ater*, *Pandemis heparana* being the indirect host. The identifications were made by Drs. K. W. R. Zwart and Mr. G. van Rossem.

Subfamily BANCHINAE

The Glyptini, represented here by the genera *Teletaea*, *Apophua*, and *Glypta*, are characterized by the presence of oblique furrows on the tergites 2, 3, and 4 (cf. figs. 14 and 15). We reared five species, viz., *Teletaea striata* (Gravenhorst), two *Apophua* and two *Glypta* species. *Teletaea striata*, the only species that was reared in considerable numbers from apple leafrollers, is easily known by its characteristic black and yellow markings.

Identification of *Apophua* and *Glypta* species provide considerable difficulties. There exists a modern revision by Aubert (1978), but identification with his key is a precarious business



Figs. 1—4. *Scambus brevicornis*: 1, head anteriorly; 2, wings; 3, gaster; 4, tip of ovipositor. Figs. 5—6. *Itopectis alternans*: 5, head anteriorly; 6, wings. Fig. 7. *Itopectis maculator*, head anteriorly. Figs. 8—9. *Apechthis quadridentatus*: 8, head anteriorly; 9, tip of ovipositor. Figs. 10—11. *Phytodietus segmentator*: 10, claw; 11, wings. Figs. 12—14. *Telectaea striata*: 12, head anteriorly; 13, thorax dorsally; 14, first four tergites. Fig. 15. *Glypta varicoxa*, gaster dorsally.

which, in our species, was not always conclusive.

We think that head, pronotum and prepectal carina show sufficient differential species characters. These will be given in the following descriptions.

Teleutaea striata (Gravenhorst)

(figs. 12—14, 89)

Colour characters. — Female and male. Preponderantly black. Clypeus, cheek beneath and mouthparts, except for the tips, yellow; antenna brown yellow. Pronotum along front margin partially and along hind margin entirely yellow. Tegula and small adjoining part of mesopleurum yellow, just like a large spot in front of middle coxa. Scutellum, postscutellum and posterior part of propodeum before the apical transverse carina yellow; coxae and legs yellow and yellowish red. Hind margins of the tergites yellowish. The extension of the yellow markings may vary considerably.

Morphological characters. — Female and male. Clypeus incised; a small unpaired tubercle before the insertion of the antennae (fig. 12). Parapsidal furrows distinct in front part of mesoscutum (fig. 13). Apical transverse carina of propodeum distinct, the other carinae absent. Abdomen, see fig. 14; second, third, and fourth tergites, especially in the male, sometimes with a longitudinal middle carina in the first third.

Length female: 7.5—12 mm, ovipositor 5—7.5 mm, length male: 8—12 mm.

This species, easily recognized by its colour pattern, was reared in large numbers from apple leafroller caterpillars, mainly from *Adoxophyes orana*, but also in small numbers from *Pandemis heparana* and *Ptycholoma lecheana*, however not from other caterpillars. There appear to be two generations which coincide with those of *Adoxophyes orana*, perhaps the reason that it appears especially adapted to this host.

Adults: 1 May—28 August. A single specimen emerged on 6 April.

Apophua cicatricosa (Ratzeburg)

(figs. 16—19, 99)

Colour characters. — Female and male. Black. Clypeus and mouth-parts yellow; antenna brownish. Upper embossed rim and hind corner of pronotum yellow; tegula, tip of scutellum and hind border of postscutellum yellow; legs yellowish brown, hind femur distally and hind tibia and tarsus darker except in the female, where the hind femur is whitish and both subproximally and distally darker. One male had no yellow markings on the thorax, except for the hind corner of pronotum and the tegula.

Morphological characters. — Female and male. Clypeus broadly rounded, without incision in the middle (fig. 16); base of mandible 1.6 as long as the

shortest distance between mandible and eye; genal carina not strongly sinuated (fig. 17). Pronotal collar separated from the rest of the pronotum by a deep groove, the collar covering the propleurum entirely, thus not visible from above; epomia long, appearing as a sharp edge, reaching to near upper edge of pronotum (fig. 18). Propodeal carinae complete and strong, more or less variable. Spur of front tibia distinctly exceeding the middle of the first tarsal segment (fig. 19).

Length female: 10 mm, ovipositor: 5.5 mm (as long as hind tibia), length male: 10 mm.

We reared seven specimens, six from *Pandemis heparana* and one from *P. cerasana*.

Adults: June, July.

Apophua sp.

This species, which we can not identify, resembles *A. cicatricosa* in many respects. Our single specimen, a female, differs from it by being somewhat larger, 11.5 mm, ovipositor 7 mm (two times length of hind tibia), having the carinae on the propodeum more oblique, and only the anterior part of the median longitudinal carinae and the costula being distinctly defined. It was reared from *Archips podana*.

Glypta nigrina (Desvignes)

(figs. 20—23)

Colour characters. — Female. Black. Clypeus with indistinct yellow markings; antenna brown. Tegula yellow; hind tibia without distinct bands, inner side whitish.

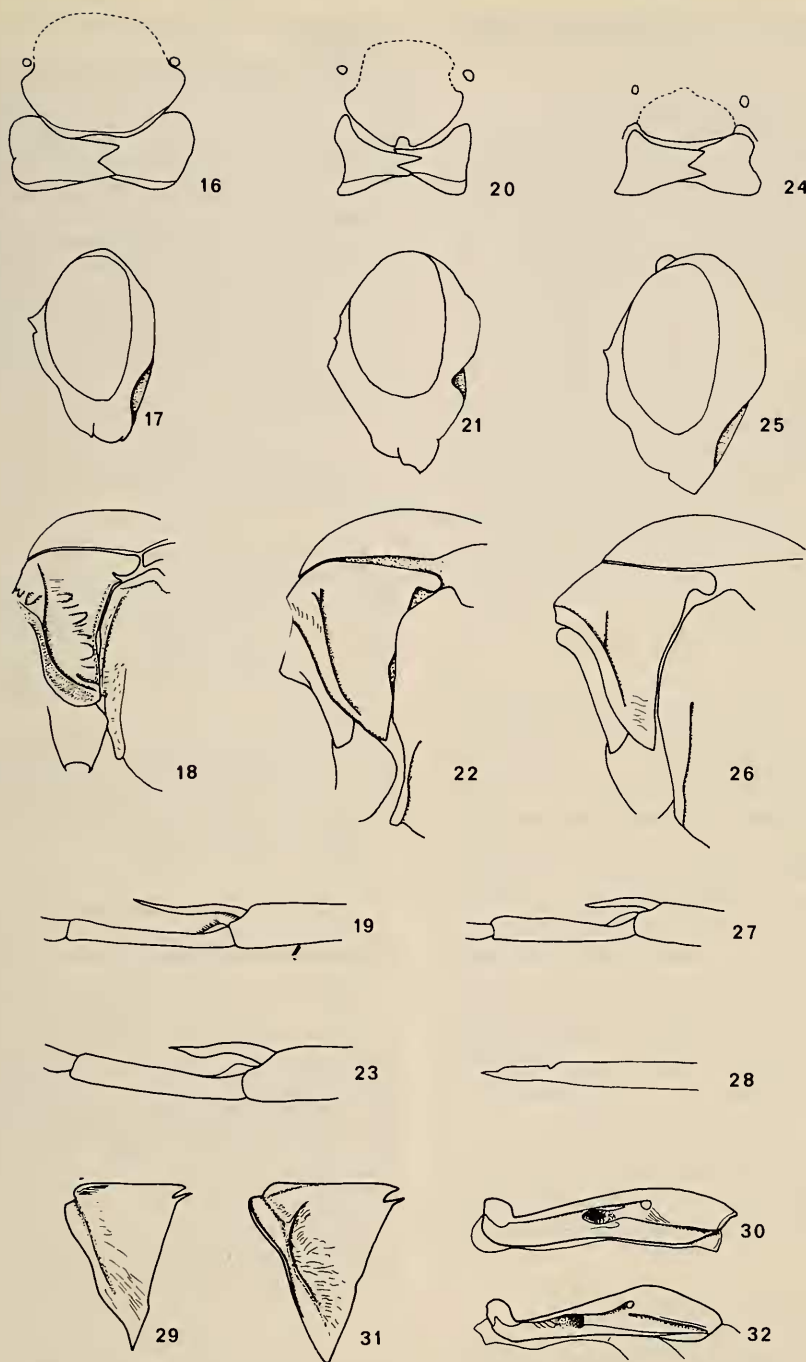
Male. As female, however clypeus yellow, its front border brownish.

Morphological characters. — Female and male. Clypeus narrow, rather convex, with small incision (fig. 20); base of mandible as long as shortest distance between mandible and eye; genal carina strongly sinuate (fig. 21). Pronotal characters similar as in *A. cicatricosa*, but less distinctly defined; collar narrower, showing lower part of propleurum, visible from above (fig. 22); pronotum rather uniformly scattered and coarsely punctate; mesopleural fovea absent. Spur of fore tibia not quite reaching middle of first tarsal segment (fig. 23).

Length female: 7—8 mm, ovipositor: 4—5 mm, length male: 8 mm.

This species seems quite similar to *Glypta varicoxa*, but may easily be distinguished by the structures of clypeus, genal carina and pronotum. Considering the length of the front tibial spur in this species, the separation between *Apophua* with the spur reaching to middle of first tarsal segment or beyond and *Glypta*, the spur not reaching to the middle, seems hardly justified.

We only reared two specimens from *Adoxo-*



Figs. 16—19. *Apophua cicatricosa*: 16, clypeus with mandibles; 17, head laterally, showing genal carina; 18, pronotum laterally; 19, tibial spur of fore leg. Figs. 20—23. *Glypta nigrina*: 20, clypeus with mandibles; 21, head laterally, showing genal carina; 22, pronotum laterally; 23, tibial spur of fore leg. Figs. 24—28. *Glypta varicoxa*: 24, clypeus with mandibles; 25, head laterally, showing genal carina; 26, pronotum laterally; 27, tibial spur of fore leg; 28, tip of ovipositor. Figs. 29—30. *Diadegma praerogator*: 29, pronotum laterally; 30, first tergite laterally. Figs. 31—32. *Tranosema arenicola*: 31, pronotum laterally; 32, first tergite laterally.

phyes orana and two from *Ptycholoma lecheana*.

***Glypta varicoxa* Thomson**
(figs. 15, 24—28, 90)

Colour characters. — Female and male. Black. Clypeus dark brownish, palps yellow, antenna brownish. Hind corner of pronotum yellow; tegula yellow; legs yellow and reddish yellow, hind tibia with subbasal and apical dark ring, hind tarsus with dark rings.

Morphological characters. — Female and male. Clypeus broadly rounded, more or less depressed in the middle, without median incision (fig. 24); base of mandible 1.5 as long as shortest distance between mandible and eye; genal carina only very shallowly sinuate (fig. 25). Pronotal collar parallel to front margin as in *Apophya cicatricosa*, but less distinct and not especially deepened between collar and front margin; propleurum visible, epomia short (fig. 26); pronotum more or less uniformly punctate, without smooth or even weakly punctate middle part; spur of front tibia not reaching to middle of the first tarsal segment (fig. 27). Tergites 2, 3, and 4 with V-shaped impressions as in other Glyptini (fig. 15); ovipositor with apical, dorsal notch (fig. 28).

Length female: 6—7 mm, ovipositor: 4.5—5 mm, length male: 5.5—7 mm.

As far as apple leafrollers are concerned, this parasite seems specialized on *Spilonota ocellana*.

Adults: 28 June—17 July.

Though the characters mentioned by Aubert (1978) do not exactly fit our species, we provisionally maintain the name; it was mentioned earlier under the same name by Evenhuis (1974b). Perhaps *G. pedata* Desvignes should be better. Both Charles (1974) and Couturier (1973) report to have reared a *Glypta* species from *Spilonota ocellana* on apple in France, which they name *G. pedata* and *G. (?) fractigena*, respectively. There can be little doubt that they refer to the same species as ours. *G. fractigena* is considered by Aubert a synonym of *G. nigrina* Desvignes. Thus either the species mentioned as *G. nigrina* in this paper, or the species stated under that name by Couturier, or perhaps both, might be misidentified. Further taxonomical investigations could elucidate these questions.

***Lissonota complicator* Aubert**

This species was mentioned earlier as *Lissonota errabunda* Holmgren (Evenhuis, 1974b). According to Aubert's key (1978) it fits better into *Lissonota complicator*.

Colour characters. — Female. Black. Antenna dark brown, mouth-parts yellow. Fore and hind margins

and hind corners of pronotum yellowish brown. Legs red yellow.

Male. Conspicuously lighter coloured than female. Black. Antenna dark brown, scape and pedicel yellow below; a yellow spot between eye and outer ocellus on each side of frons; face and mouth-parts yellow, with black middle stripe extending from insertion of antennae downwards, not reaching front margin of clypeus. Front margin of pronotum lighter and with yellow spot on the outer hind corners; mesoscutum broad yellow on the front margin on each side, tegula yellow; legs red brown, fore and middle coxae and trochantera whitish yellow, hind coxa darker, hind tibia distally and first three segments of hind tarsus darkened. Hind borders of proximal tergites lighter.

Morphological characters. — As Aubert (1978) gives predominantly colour characters and as we have no specimens of related species to compare, we should refrain from giving morphological characters.

Length female: 4.5—6.5 mm, ovipositor: 5 mm, length male: 4—5.5 mm.

We reared this parasite in rather large numbers from caterpillars of *Archips podana* on apple. It might be a rather strictly specialized parasite of this leafroller. However, we saw Swiss specimens reared from a caterpillar of *Pandemis cerasana* by Dr. A. Schmid, Nyon, Switzerland.

It is a gregarious larval endoparasite with varying ratios of females and males per host. From one single host caterpillar 3 to 8 parasites emerged with an average of 6.

Adults: 11 June—15 July.

Subfamily PORIZONTINAE

***Diadegma praerogator* (Linnaeus), (*Diadegma interrupta* (Holmgren) (Horstmann, 1973))**
(figs. 29, 30)

Colour characters. — Female and male. Black. Mouth-parts yellow. Tegula yellow; fore and middle coxae often partly yellow; fore and middle trochantera yellow; femora light brown, hind tibia yellowish white, with broad basal and apical dark rings, all tarsi light brown, distally darker, last tarsal segment especially dark.

Morphological characters. — See *Tranosema arenicola*.

Length female *D. praerogator*: 4—6.5 mm, ovipositor: 1—1.5 mm, length male: 3.5—5.5 mm.

This species is one of the most common parasites of apple leafrollers. We reared it from caterpillars of several leafroller species (cf. table 1). Till yet we did not rear it from caterpillars of other families of Lepidoptera on apple, representatives of which, however, were only collected in relatively small numbers. Neither does

Herting (1965) mention it from Geometridae and Noctuidae on apple. Thus we consider *Diadegma praerogator* as a parasite, specialized on Tortricidae.

Townes (1969) referred *Diadegma interrupta* to the genus *Tranosema* Förster. Horstmann in his type revision of the European *Diadegma* species, placed *D. interrupta* in the subgenus *Nythobia* Förster, which contains the extremely uniform majority of the *Diadegma* species. The latter of course seriously interferes with species identification. Often males cannot be identified at all, because important characters, as eventual notches in the hind borders of the posterior sternites and the length and shape of the ovipositor, refer to the female sex only.

Adults: 13 May—7 October.

We reared some more *Diadegma* species from apple leafrollers, but only in very small numbers. They were identified by Dr. K. Horstmann as *D. apostata* (Gravenhorst), and as *D. fenestralis* (Holmgren). Three further specimens could not be identified.

Tranosema arenicola (Thomson) (figs. 31, 32)

Colour characters. — Female. As in *Diadegma praerogator*, however legs entirely light brown, but fore and middle coxae darker brown or even partly black, hind tarsus darkened.

Male. As female, but fore and middle coxae light brown.

Morphological characters. — The morphological characters may be treated together with those of the other Porizontini. As their general appearance is rather alike, it seems useful to compare some of their differentiating characters here. In the three *Diadegma* species mentioned above, the epomia is lacking (fig. 29), whereas this is short but evident in *Tranosema arenicola* (fig. 31). The lateral carinae on the first abdominal segment, running from its hindborder forward, are evident in the three *Diadegma* species and pass distinctly beneath the spiracles (fig. 30); in *Tranosema arenicola* they stop distinctly quite near the spiracle (fig. 32). As two of the *Diadegma* species that we reared are not important as apple leafroller parasites at all, it will be enough to refer to the publication of Horstmann (1969) for the differentiating characters. Horstmann (1973) discussed the similarity of *Diadegma praerogator* and *Tranosema arenicola*.

Length female *T. arenicola*: 5.5—6.5 mm, ovipositor: 1.5—2 mm, length male: 4.5—5.5 mm.

Tranosema arenicola was quite often reared from several leafroller species, however, far the most from *Archips rosana*. It is a solitary, larval endoparasite.

Adults: 14 June—26 July. A single specimen hibernated; the adult appeared on 7 May.

Campoplex spp.

Campoplex is a very large genus, like so many genera of Porizontinae. It gives tremendous difficulties in species discrimination. No modern revision of the genus exists. Therefore, in most cases reliable identification is impossible. Because our material from apple leafrollers is only scanty, we do not want to go into details.

We obtained five specimens from *Pandemis cerasana*, *Adoxophyes orana* and *Acleris rhombana*, which were identified by Dr. K. Horstmann as possibly *Campoplex difformis* Gravenhorst. Six further specimens, no doubt conspecific and of which five were reared from *Spilonota ocellana*, could not be identified, just like 13 specimens, probably belonging to at least three species, reared from several leafroller species.

Subfamily MESOCHORINAE

According to Townes (1971) the species belonging to this subfamily are secondary parasites through Ichneumonidae, Braconidae, Tachinidae (Diptera) and probably other families as direct hosts. He does not give information on indirect hosts. It is not excluded that some species might be primary parasites.

We reared only four specimens, a male and a female of *Mesochorus silvarum* Curtis and two males of *Stictopisthus lineatus* Thomson (det. Prof. Dr. W. Schwenke). The two specimens of the former species were reared from the caterpillars of *Pandemis cerasana* and *Adoxophyes orana*, respectively. The two specimens of the latter species were reared from a cocoon of probably *Meteorus ictericus* (Braconidae) without caterpillar host remains, and from a caterpillar of *Adoxophyes orana*, respectively.

Subfamily METOPIINAE

We reared only a few specimens of this subfamily, belonging to four species. They can easily be recognized, especially by their smooth body and the conspicuously short and stout legs (fig. 96); they are all larval-pupal parasites.

Triclistus Förster

The western palaearctic species have been dealt with by Aeschlimann (1973). Our material contains two species, that were identified by Dr. Aeschlimann as *Triclistus pallipes* Holmgren and *Triclistus globulipes* (Desvignes).

Triclistus pallipes Holmgren

(figs. 33, 34, 96)

Ten specimens of this species, all females, were reared exclusively from *Rhopobota naevana*. Aeschlimann (1973) mentions *Strophedra weirana* (Lepidoptera, Tortricidae) as a host, which species is associated with *Fagus* and *Carpinus*.

Adults: 16 May—15 June.

Triclistus globulipes (Desvignes)

(figs. 35—37)

Morphological characters. — Figures 33—36 show differences in the form of the head and in the pattern of pubescence on the gaster in both *Triclistus* species. Fig. 37 shows the propodeum of *T. globulipes* with the longitudinal carinae.

Of this species we reared two females, *Archips podana* being the host, and one male from *Archips xylosteana*. Aeschlimann (1973) mentions five more Tortricid host species.

Adults: 7 July—9 August.

Exochus Gravenhorst

We reared two species, each represented by one specimen, from pupae of *Clepsis spectrana* and *Acleris rhombana*. As there is no modern revision of the genus, it is not possible to name the two species.

Exochus sp. 1

(fig. 38)

Colour characters. — Black. Head and mouth-parts, except ocellar area, bright yellow; scape black and yellow, rest of antenna brown, underside lighter. Thorax conspicuously marked with yellow; legs bright yellow, hind femur basally and apically black.

Morphological characters. — See *Exochus* sp. 2. Fig. 38 shows the propodeum with peculiarly shaped longitudinal carinae.

This species was reared from *Acleris rhombana*.

Adult: 7 July.

Exochus sp. 2

Colour characters. — Black. Antenna apically brownish, coxae and trochantera dark brown, remainder of legs lighter.

Morphological characters. — Differs from the former species in having basal vein less curved and having complete costulae.

This species was reared from *Clepsis spectrana*.

Subfamily ANOMALONINAE

The species of this subfamily are larval-pupal parasites. We reared only six specimens, belonging to two species. Two specimens of *Habronyx* (*Camposcopus*) *canaliculatus* (Ratzeburg) were reared from *Archips rosana*. Four specimens, belonging to *Agrypon anxium* (Wesmael), were reared from *Acleris rhombana* (three specimens) and from *Spilonota ocellana* (one specimen). The subfamily was recently treated by Gauld & Mitchell (1977).

Adults of *Habronyx canaliculatus*: 7 July—19 July. Adults of *Agrypon anxium*: 9 June—24 July.

Family BRACONIDAE

Reliable identification of the species of Braconidae that parasitize apple leafrollers seems only exceptional. The difficulties will be discussed in the special cases. As to the division into subfamilies we follow Van Achterberg (1976).

Subfamily MICROGASTRINAE

Apanteles Förster

Two species of this very large genus, viz., *A. ater* (Ratzeburg) and *A. xanthostigma* (Haliday), may be considered the most important *Apanteles* species associated with apple leafrollers by far (Evenhuis & Vlug, 1973). Nixon (1965, 1973) gave a division in groups; in several publications he dealt with the species in detail (Nixon, 1972, 1973, 1974, 1976). Several groups of Nixon are treated as independent genera by Mason (1981).

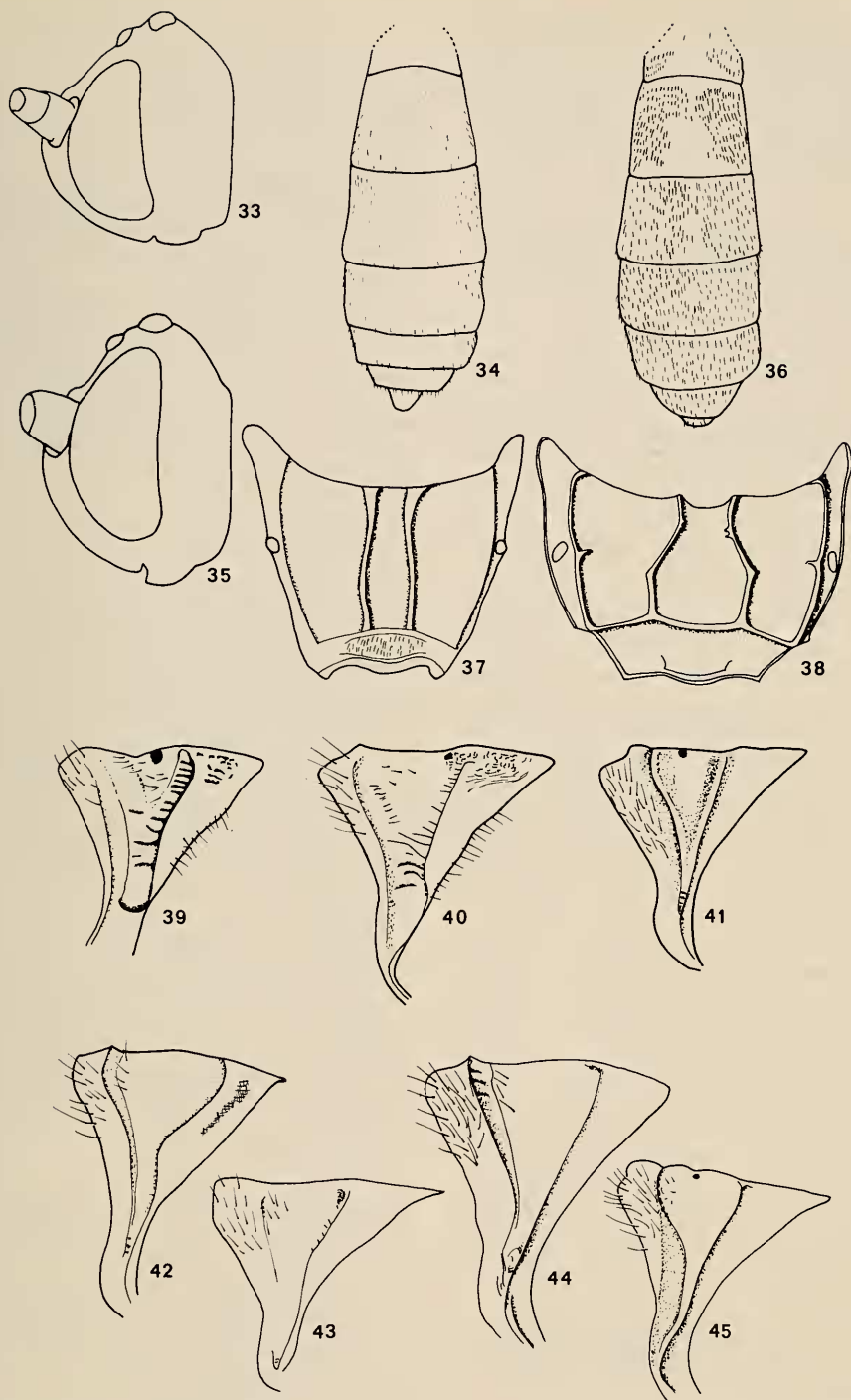
We reared seven species from apple leafrollers. They may be distinguished especially by characters of the pronotum (figs. 39—45), of colouration of the pterostigma (figs. 46—52), of hind wing venation and of propodeum and tergite of the first gastral segment (figs. 53—59).

Apanteles ater (Ratzeburg)

(figs. 39, 47, 53, 60)

Colour characters. — Female and male. Preponderantly black. Mouth-parts, distal part of fore femur, fore tibia, fore tarsus, base of middle tibia, middle tarsus and all tibial spurs lighter. Wing veins for the greater part pale, however costal vein and pterostigma distinctly pigmented; the parts of 2r proximally of Rs and short distal part of M less distinctly pigmented; pterostigma brownish yellow in the center, margins darker (fig. 47).

Morphological characters. — Female and male. Propodeum with two distinct carinae, converging in



Figs. 33—34. *Triclistus pallipes*: 33, head laterally; 34, gaster dorsally. Figs. 35—37. *Triclistus globulipes*: 35, head laterally; 36, abdomen dorsally; 37, propodeum. Fig. 38. *Exochus* sp. 1: propodeum. Figs. 39—45. Microgastrinae spp., pronotum laterally: 39, *Apanteles ater*; 40, *A. xanthostigma*; 41, *Dolichogenidea sicaria*; 42, *D. laevigata*; 43, *D. corvina*; 44, *D. dilecta*; 45, *D. longicaudus*.

front and thus forming a V, a little coarse, but smooth and shiny between and just outside the keels. First tergite twice as long as broad, the sides rather strongly converging distally (fig. 53). Ovipositor valves about as long as hind tibiae.

Length female: 2—2.5 mm, ovipositor: 0.5—1 mm, length male: 2—2.5 mm.

Nixon (1976) states that this species is poorly characterized as a whole, but that it is easily recognizable in the female by the presence of a fine, curved spine on the ventral side of the last tarsal segment of the front leg (fig. 60).

This species has been treated by Wilkinson (1945) in such an accurate way, that we have no doubt about its identity. This author also studied Ratzeburg's type material. The species was originally described as *Microgaster carbonarius* Ratzeburg, 1848, but later on renamed *Microgaster ater* Ratzeburg, 1852, as the former name appeared to be preoccupied by *Microgaster carbonarius* Wesmael, 1837.

Ratzeburg (cf. Evenhuis & Vlug, 1973) states about the host: "Von mir aus versponnenen Apfelblüthen erzogen, wahrscheinlich aus der *brumata*, die diese versponnen hatte". However, the host may as well have been some species of Tortricidae instead of *Operophtera brumata*. Wilkinson states the parasite to have been reared from *Cacoecia* (= *Archips*) *podana*, *Hyponomeuta malinella* (= *Yponomeuta malinellus*), *Tortrix* (= *Lozotaenia*) *forsterana*, *Notocelia udmanniana*, and a specimen from a leafroller of *Ribes nigrum*. From this enumeration only *Yponomeuta malinellus* does not belong to the Tortricidae. It does not seem improbable that the mention of this host is due to a mistake, as *Yponomeuta* caterpillars live gregariously in large nests and some Tortricid host caterpillar may have been mixed with them.

According to our opinion *Apanteles ater* must be considered a specialized parasite of the caterpillars of various Tortricidae. However, the species seems to show some preference for the larger caterpillars. We reared rather many specimens, almost exclusively from *Archips podana* and *Pandemis heparana*, but only a few from *Adoxophyes orana*, *Ptycholoma lechleana*, and *Acleris* spp.

This is the only gregarious species within the genus that we reared from leafrollers associated with apple. Like other *Apanteles* species it is a larval endoparasite.

Adults: 25 May—18 September.

Apanteles xanthostigma (Haliday) (figs. 40, 46, 54)

This species is very similar to the preceding one, both in colour and in morphological respect.

Colour characters. — Female and male. The species differs from *A. ater* by the centre of the pterostigma being more yellowish instead of white (fig. 46) and in the female sex by the legs being more extensively light-coloured.

Morphological characters. — Female and male. The most striking difference with the preceding species is, according to our opinion, the structure of the propodeum. This contains a longitudinal trough in the middle, which is at least distinct in its hind part and there bordered by short longitudinal carinae (fig. 54). The propodeum, on the whole, is also coarser. The female does not have a curved spine on the last tarsal segment of the fore leg.

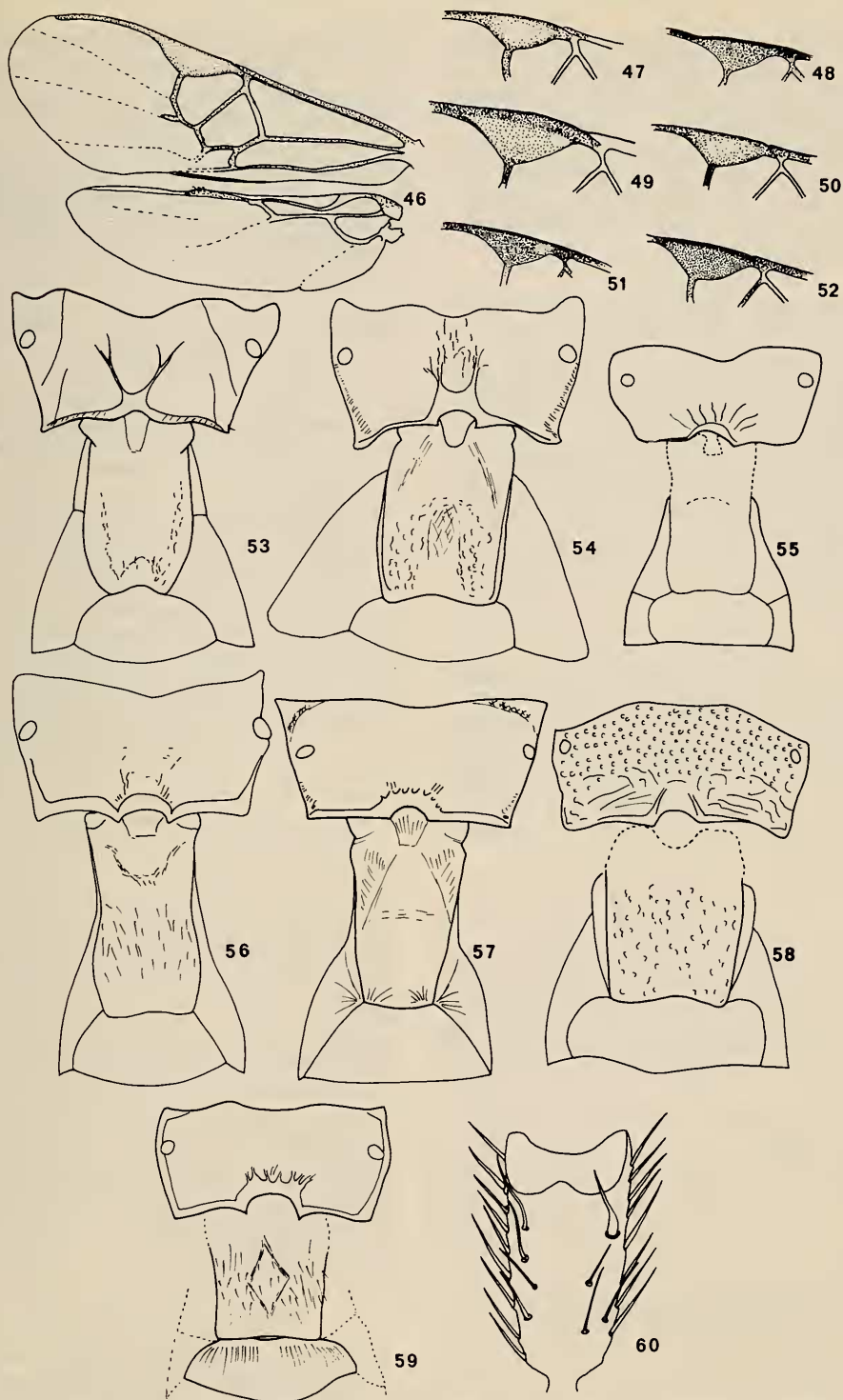
Length female: 2.5—3 mm, ovipositor: 0.5—1 mm, length male: 2.5—3 mm.

The species has been dealt with by Nixon (1976), who mentions a number of hosts, belonging to several families of Microlepidoptera. Telenga (1955) also enumerates the hosts, belonging to various Lepidopterous families. Zwölfer (1962) characterizes its host preference as follows: „Die von uns seit einigen Jahren untersucht, recht polyphage Braconide *Apanteles xanthostigma* Hal. beschränkt ihr Suchgebiet praktisch auf die Strauch- und Baumschicht, greift hier aber eine grössere Zahl von Wirten, meist Wickler und verwandte Kleinschmetterlingsgruppen an“.

We reared a large number of specimens from several leafroller species of apple (cf. table 1), but we have no experience with the hosts of other Lepidopterous families. If indeed only one and the same species is involved, it might be considered a polyphagous parasite of Lepidoptera. *Apanteles xanthostigma* is a solitary endoparasite.

Adults: 13 May—8 September.

Besides the two species mentioned, we reared some more Microgastrinae, however in quite low numbers: *Dolichogenidea corvina* (Reinhard) from Nixon's "metacarpalis" group; *Dolichogenidea laevigata* (Ratzeburg), *D. dilecta* (Haliday), *D. sicaria* (Marshall) and *D. longicaudus* (Wesmael) from Nixon's "laevigatus" group. As these species have been dealt with thoroughly in taxonomical respect by Nixon



Figs. 46—60. Microgastrinae spp. 46, *Apanteles xanthostigma*, wings. 47—52, pterostigma: 47, *Apanteles ater*; 48, *Dolichogenidea sicaria*; 49, *D. laevigata*; 50, *D. corvina*; 51, *D. dilecta*; 52, *D. longicaudus*. Figs. 53—59. Propodeum and first tergites: 53, *Apanteles ater*; 54, *A. xanthostigma*; 55, *Dolichogenidea sicaria*; 56, *D. laevigata*; 57, *D. corvina*; 58, *D. dilecta*; 59, *D. longicaudus*. Fig. 60. *Apanteles ater*, last tarsal segment of fore leg of female ventrally.

(1972, 1973) and as they apparently do not play any important role in the natural control of apple leafrollers, it does not seem necessary to treat them here in detail.

Our material is far too poor to allow any conclusion as to their host specialization. In figs. 39—60, morphological details of the several *Apanteles* species are given, which may be sufficient to separate them.

Twelve further specimens of the subfamily Microgastrinae, all belonging to the genus *Lisogaster* Bengtsson (= *Microgaster* auct.), were reared. They belong to at least four species and apparently are not important as parasites of apple leafrollers.

Nixon (1965) states: "Taxonomically, *Microgaster* is in a state of confusion and with regard to European species, there has been no improvement on Thomson's treatment of the genus". Thomson's work appeared between 1869 and 1897!

Subfamily AGATHIDINAE

We reared only two species of this subfamily from apple leafrollers. Both species seem, at least within the host range that we investigated, restricted to *Spilonota ocellana* and are rather common solitary endoparasites. The subfamily may be easily recognized by the very narrow radial cell in the fore wing (fig. 64). Notauli deep in both species.

Agathis dimidiator (Nees) (figs. 61—63)

Colour characters. — Female. Black. Mouth-parts yellow. Legs reddish yellow, often with somewhat lighter trochantera; hind coxa black or largely black; hind tibia in the distal two third more or less black, for the rest whitish, lighter as the remainder of the legs; hind tarsi and ultimate ends of fore and middle tarsi dark.

Male. As female, but second gaster segment conspicuously light.

Morphological characters. — Female. The most salient characters of this species are, in comparison with the next one, the head elongated downwards slightly (fig. 61) and the first and generally the second tergite being partly rather coarsely striated longitudinally (fig. 62).

Male. As female, but striae on second tergite largely varying and in some cases even lacking (fig. 63).

Length female: 4—4.5 mm, ovipositor: 3.5 mm, length male: 4—4.5 mm.

The characters given here, borrowed from Telenga (1955) who placed the species in the ge-

nus *Microdus* Nees, are rather doubtful. A revision of this genus and allied genera seems urgent. Until so far we shall use the species name *dimidiator*, quoted from Telenga (1955).

As stated above we reared this species only, but rather commonly, from *Spilonota ocellana*. Telenga (1955) mentions *Archips rosana*, *Croeisia bergmanniana* and *Epinotia tetraquetra* as hosts, all Tortricids.

Adults: 4 July—13 August.

Agathis rufipes (Nees) (*Braunsia rufipes* (Nees) (in Telenga, 1955)) (figs. 64—66)

Colour characters. — Female and male. Black. Mouth-parts, tegula and legs reddish yellow, except for the extreme distal end of the hind tibia and the greater part of the hind tarsus; tibial spurs all more or less whitish.

Morphological characters. — Female and male. As in the former species first radial and discoidal cells fused (fig. 64). Distal part of first tergite with fine longitudinal striation; base smooth, in contrast to the former species, where it is wrinkled all over its surface (figs. 65, 66); on each side a conspicuous, dorsolateral carina that does not reach the hind border, these carinae more lateral and thus inconspicuous in the former species. There are transverse grooves in the middle of each of the fused second and third tergites, so that it seems if one long tergite after the first tergite were divided into four sections by three transverse grooves; striation of first tergite continuing onto the first two sections.

Length female: 4—5 mm, ovipositor: 3.5 mm, length male: 4—5 mm.

This species superficially resembles the former in many respects, may, however, easily be distinguished from it by the colour of the hind legs and by the sculpture of the gaster, as mentioned.

We reared this species only from *Spilonota ocellana*, but rather commonly. Telenga (1955) mentions quite a lot of host species, which may at least be partly erroneous, especially where non-Lepidopterous hosts are involved. Betz & Schwerdtfeger (1970) mention one specimen that was reared from *Teleia luculella* (Lepidoptera, Gelechiidae) on oak.

Adults: 29 June—30 July. A single specimen appeared on 8 June.

Subfamily CHELONINAE

From this subfamily we reared only two *Ascogaster* species. Though both species superficially resemble each other very much, they may be easily distinguished. Just like other

members of the subfamily, as far as known, they are solitary egg-larval endoparasites.

***Ascogaster quadridentata* Wesmael**
(figs. 67—69)

Colour characters. — Female and male. Black. Scape for the greater part, rest of the antenna down-side, trochantera, fore femur distally, and fore tibia reddish yellow; tibial spurs whitish yellow; middle leg in male often a little lighter, at least tibia proximally.

Morphological characters. — Female and male. Head with coarse sculpture, clypeus produced in a small angle (fig. 67). Thorax and abdomen with coarse sculpture, coarser than head, thorax coarsest (fig. 68). Horizontal front part and perpendicular hind part of propodeum distinctly separated; the boundary line with four strong teeth, from which the inner are a little smaller than the outer (fig. 69).

Length female and male: 3.5—4 mm.

The female lays the egg in the host egg, and the adult parasite emerges from the full-grown or almost full-grown caterpillar (Cox, 1932). *Ascogaster quadridentata* seems specialized on Tortricidae Olethreutinae; the females of these moths lay their eggs separately on the host plants (Evenhuis, 1969, 1974). We reared this species commonly from *Spilonota ocellana* and *Hedya nubiferana*. It is a well-known parasite of *Laspeyresia pomonella*.

Adults: 19 June—24 July.

***Ascogaster rufidens* Wesmael**
(figs. 70—72)

Colour characters. — Female and male. Black. Mandible, palps, antenna basally downside, tegula, trochantera, femora and tibiae reddish yellow; middle of the tibiae and femora of the middle and hind legs a little darker; tibial spurs whitish yellow.

Morphological characters. — Female and male. Sculpture somewhat less coarse than in the preceding species. There are three small, reddish teeth on the lower border of the clypeus (fig. 70). Wesmael (1835) (see Fahringer, 1934) mentions this explicitly.

Length female and male: 3.5—4.5 mm.

These characters, combined with others mentioned by Wesmael in his detailed description, are sufficient to recognize the species. Characters of mesoscutum and propodeum, to be compared with those of *A. quadridentata*, are shown in figs. 71 and 72, respectively.

This species resembles the preceding one, but may be distinguished at once by the colour of the legs — preponderantly black in *A. quadridentata* and reddish yellow in *A. rufidens* — and by the structures of the propodeum.

In contrast to the former species, its hosts

seem restricted to the Tortricidae Tortricinae, which lay their eggs in batches. We reared many specimens, especially from *Pandemis cerasana* and *P. heparana*, but also often from *Adoxophyes orana*. Matthey (1967) reared the species from *Pandemis cerasana*, *P. corylana* and *Batodes angustiorana* on oak.

Adults: 25 May—21 July.

Subfamily EUPHORINAE

***Meteorus ictericus* (Nees)**
(figs. 73—75, 95)

Colour characters. — Female. Reddish yellow. Antenna and ocellar space darker. Often the whole thorax is entirely dark or even black, except for the greater part of the prothorax. In some specimens only the propodeum is dark and often the distal ends of the tibiae and the tarsi. Often the first tergites and the middle part of the last tergites are black, or the abdomen is almost completely black except for the fused second and third tergites.

Male. As female, but often a little lighter.

Morphological characters. — Female and male. In figs. 73, 74 and 75, thorax and the first three tergites are shown, which might be of interest in the separation of this species. The propodeum is more or less irregularly reticulated and shows some variability; in specimens reared from *Adoxophyes orana* it seems coarser than in other specimens. The first gastral segment shows longitudinal wrinkles and two dorsal pits (dorsope: van Achterberg, 1974).

Length female: 3.5—5 mm, ovipositor: 2 mm, length male: 3.5—4.5 mm.

According to Fischer (1970) a critical revision of the species of *Meteorus* belongs to the most difficult questions in the taxonomy of Braconidae. The genus as such may be easily recognized, but separation of the many species is often extremely difficult. In Fisher's key our species runs to *Meteorus ictericus*. A critical revision of the Palaearctic species is given by Huddleston (1980).

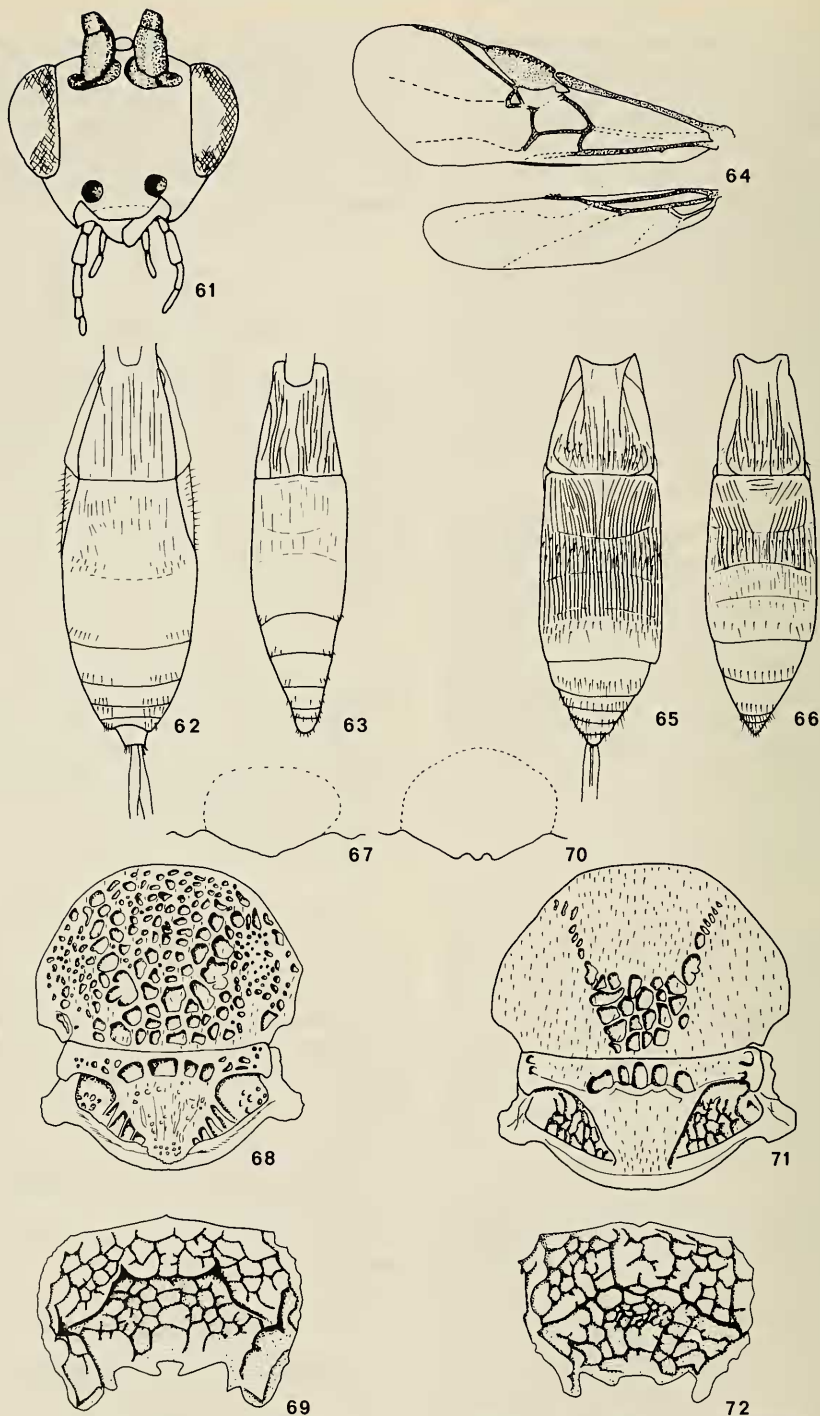
This parasite is one of the most common species that we reared from several apple leafroller species (cf. table 1).

Adults: 2 May—28 August. A single specimen appeared on 6 April.

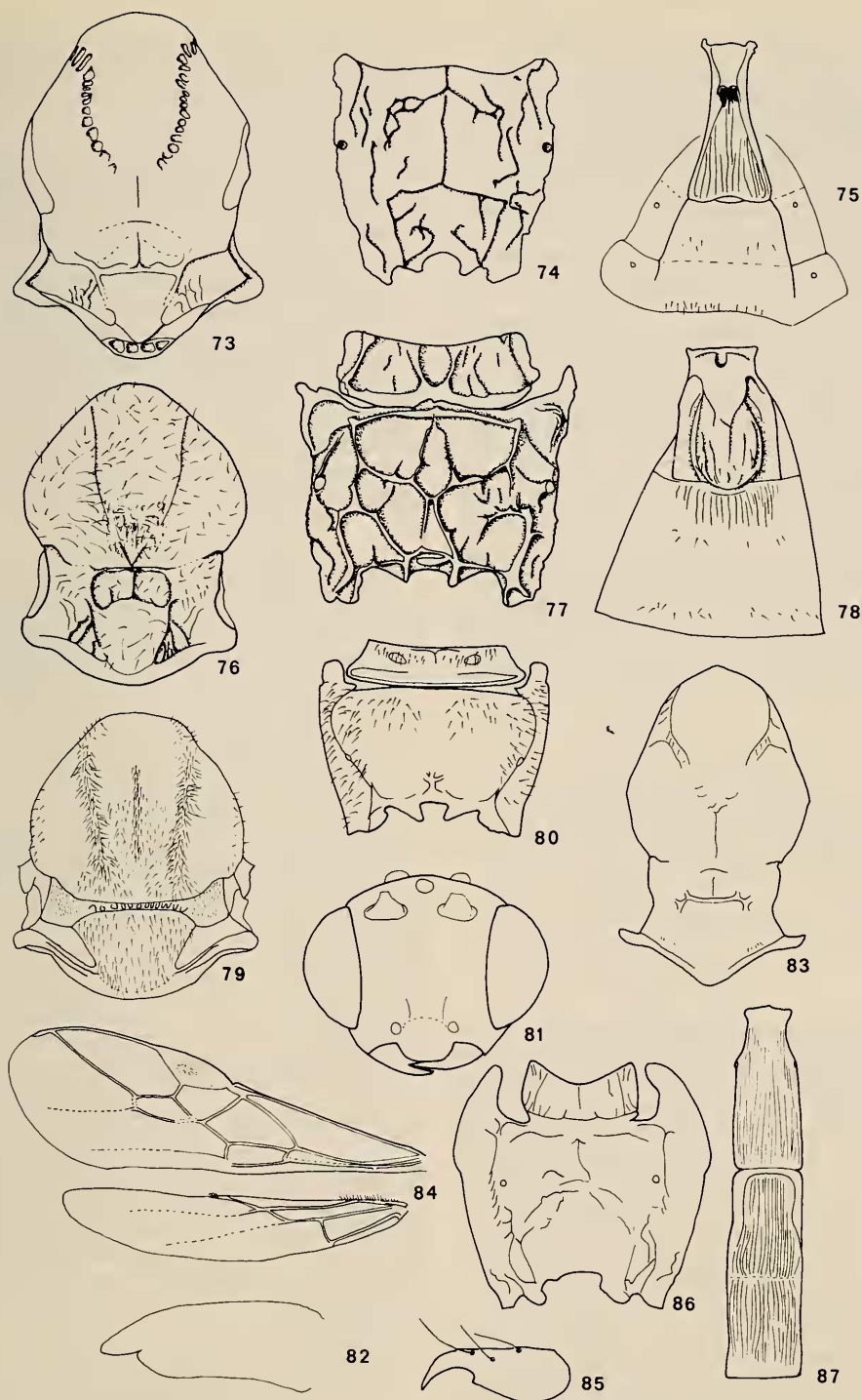
Subfamily ROGADINAE

***Oncophanes minutus* (Wesmael)**
(figs. 76—78)

Colour characters. — Female. Body dark or even black. Basal part of antenna brown, mouth-parts, including palps, yellowish. Legs and ovipositor yellow. Pronotum partly, tegula and extreme superior part of



Figs. 61—63. *Agathis dimidiator*: 61, head anteriorly; 62, gaster female dorsally; 63, abdomen male dorsally. Figs. 64—66. *Agathis rufipes*: 64, wings; 65, gaster female dorsally; 66, gaster male dorsally. Figs. 67—69. *Ascogaster quadridentata*: 67, front edge of clypeus; 68, thorax dorsally; 69, propodeum. Figs. 70—72. *Ascogaster rufidens*: 70, front edge of clypeus; 71, thorax dorsally; 72, propodeum.



Figs. 73—75. *Meteorus ictericus*: 73, thorax dorsally; 74, propodeum; 75, first three tergites. Figs. 76—78. *Onophanes minutus*: 76, thorax dorsally; 77, propodeum; 78, first three tergites. Figs. 79—80. *Bracon* sp.: 79, thorax dorsally; 80, propodeum. Figs. 81—87. *Macrocentrus linearis*: 81, head anteriorly; 82, mandible; 83, thorax dorsally; 84, wings; 85, tarsal claw; 86, propodeum; 87, first three tergites.

mesopleurum reddish brown. Second tergite for the greater part yellowish.

Male. As female, but second tergite not as yellow.

Morphological characters. — Female and male. The exact difference between *Oncophanes minutus* and *O. laevigatus* (Ratzeburg) (= *O. lanceolator* (Nees)) is not clear from Fahringer's revision (1930). This is the last revision of the genus anyway! Occipital carina above fine, but distinct. Mesopleurum polished, but extreme superior part coarse. Mesoscutum sparsely covered with fine long hairs, parapsidal furrows evident (fig. 76). Propodeum with delimited areas (fig. 77). First tergite striated longitudinally, in front with two distally converging carinae, space between carinae smooth. Second and third tergites only separated by a shallow, in the middle almost faded transverse groove, second tergite longitudinally striated. The extension of this striation shows a rather large variability (fig. 78).

Length female: 2—2.5 mm, ovipositor: 0.5 mm, length male: 2 mm.

Oncophanes minutus is a gregarious ectoparasite. We reared it almost exclusively from *Adoxophyes orana* and only from a few localities. It must be considered an occasional parasite of apple leafrollers, without economic importance.

Adults: 6 August—26 August.

Subfamily HOMOLOBINAE

Charmon cruentatus Haliday

We reared only one specimen from a caterpillar of *Spilonota ocellana*. It was identified by Dr. C. van Achterberg, Leiden.

Subfamily BRACONINAE

Bracon sp. (figs. 79, 80)

Among Braconidae *Bracon* is one of the largest genera. It is considered one of the most difficult genera of the Hymenoptera. A modern revision is lacking and sufficient reliable species characters are not known at the moment. There are many morphological differences between this species and the preceding one. We shall describe some that are most conspicuous, hoping that they may be an indication for the identity of the species, after the genus, eventually the group to which it belongs, has been revised.

Colour characters. — Female. Body dark, locally lighter, especially thorax and gaster downside.

Morphological characters. — Female. Mesoscutum smooth, with percurrent, converging notauli (fig. 79), which do not meet distally. Notauli shallow, with long setae, orientated mainly in two directions, inwards and outwards. Hind part of mesoscutum and

also scutellum densely pilose. Propodeum smooth, without areas (fig. 80). First tergite with two deep, distally converging grooves that enclose a triangular field.

Length female: 2.5 mm.

Of this species we only reared one female from *Adoxophyes orana*, which emerged on 12 August.

Bracon obscurator Nees

This species differs from the former by its smaller size and by the mesoscutum being much less pilose, the hairs on its hind part almost lacking. It was, provisionally, identified by Dr. C. van Achterberg.

Length male: 1.5—2 mm.

We reared two males from one caterpillar of *Spilonota ocellana*.

Subfamily MACROCENTRINAE

In this subfamily three *Macrocentrus* species were reared from apple leafrollers, mainly *M. linearis* (Nees), and a few specimens of the related *M. pallipes* (Nees) and one specimen of *M. thoracicus* (Nees). A modern revision of *Macrocentrus* is that of Eady & Clark (1964).

Macrocentrus linearis (Nees) (figs. 81—87)

Colour characters. — Female and male. Preponderantly light brownish, however variable. Interocellar space and a point on both sides of the insertion of the wings very dark to black. Upper side of thorax and gaster often dark in varying tinge and extension. Pterostigma dark centrally, with lighter margins (fig. 84).

Morphological characters. — Female and male. As morphological differences with related species have been dealt with by Eady & Clark (1964), we refer to that publication. We may add that the mesopleurum in this species is rather uniformly and widely punctate at its centre and not more densely in the furrow, which is only slightly pronounced; prepectal carina strongly curved (in *M. pallipes* the mesopleurum is irregularly punctate, and especially in the shallow, however pronounced furrow above the hind coxae densely punctate; prepectal carina straight). Figs. 81—87 show head, mandible, thorax above, wings, tarsal claw, propodeum, and first three tergites, respectively.

Length female: 4—5 mm, ovipositor: 6 mm, length male: 4—5 mm.

We reared this parasite often from *Pandemis cerasana*, *P. heparana* and *Archips podana*, thus from the larger leafroller caterpillars. After Eady & Clark (1964) the parasite has also been

reared from other Microlepidoptera than Tortricidae.

It is a gregarious larval endoparasite, apparently showing polyembryony. In most cases the progeny of one single host consists of either males or females exclusively. However, in a number of cases we reared both sexes from one single host, probably indicating that then at least two eggs were laid in a single host, giving rise to a female and a male progeny respectively.

Adults: 26 June—11 August.

Macrocentrus pallipes (Nees)

This species is very similar to the preceding one. Differentiating characters have been given by Eady & Clark (1964); a few supplementary characters were mentioned under *M. linearis*.

We reared 18 female specimens from one single caterpillar of *Hedya nubiferana*.

One specimen of *Macrocentrus thoracicus* (Nees) was reared from a caterpillar of *Spilonota ocellana*. It was, just like *M. linearis* and *M. pallipes*, identified by Dr. C. van Achterberg, Leiden.

Superfamily CHALCIDOIDEA

This superfamily of parasitic Hymenoptera has found a number of prolific workers during the last decennia. Especially from the groups that interest us as parasites of apple leafrollers, there exist some modern taxonomic revisions.

Only one species, *Colpoclypeus florus*, is of real importance in respect to apple leafrollers; the others were only reared in small numbers. Thus we will not treat them in detail and, as far as their identity is involved, refer to the revisions.

Family PTEROMALIDAE

Habrocytus chrysos (Walker)

(fig. 101)

This species has been dealt with by Graham (1969). We reared only three specimens as hyperparasites of the caterpillars of *Adoxophyes orana* through *Scambus brevicornis*, *Onophanes minutus* and an unidentified Ichneumonid, respectively. Graham mentions some more hosts, so that *H. chrysos* must be considered a widely specialized hyperparasite of various Lepidoptera, through various species of parasitic Hymenoptera as direct hosts.

Adults: 28 September.

Habrocytus semotus (Walker)

We reared this species three times from apple leafrollers, namely once as a hyperparasite of *Archips podana* through *Scambus brevicornis* and two times from pupae of *Adoxophyes orana*, possibly as hyperparasites.

Graham (1969) mentions the parasite both as a primary and as a secondary parasite of various Lepidoptera, but also from certain Coleoptera and in one case from Hymenoptera Diprionidae.

Adults: 25 August—25 September.

Dibrachys cavus (Walker)

(figs. 97, 102)

According to Graham (1969) the species of *Dibrachys* have not yet been fully sorted out. On the authority of Peck (1963) he mentions *Dibrachys cavus* to be a very polyphagous parasite, usually hyperparasitic.

We reared only two small specimens from cocoons of *Apanteles ater*, parasitizing a caterpillar of *Pandemis* sp. and two specimens from a cocoon of *Diadegma* sp., *Archips podana* being the host.

Adults: 6 July.

Family EULOPHIDAE

Phygadeuon pectinicornis (Linnaeus)

We reared only two specimens of this species, the hosts being caterpillars of *Adoxophyes orana* and *Rhopobota naevana*, respectively. Askew (1968) mentions it as a parasite of Microlepidoptera, especially of *Lithocolletis* (= *Phyllonorycter*), which are leafminers.

Adults: 4 September.

Sympiesis xanthostoma (Nees)

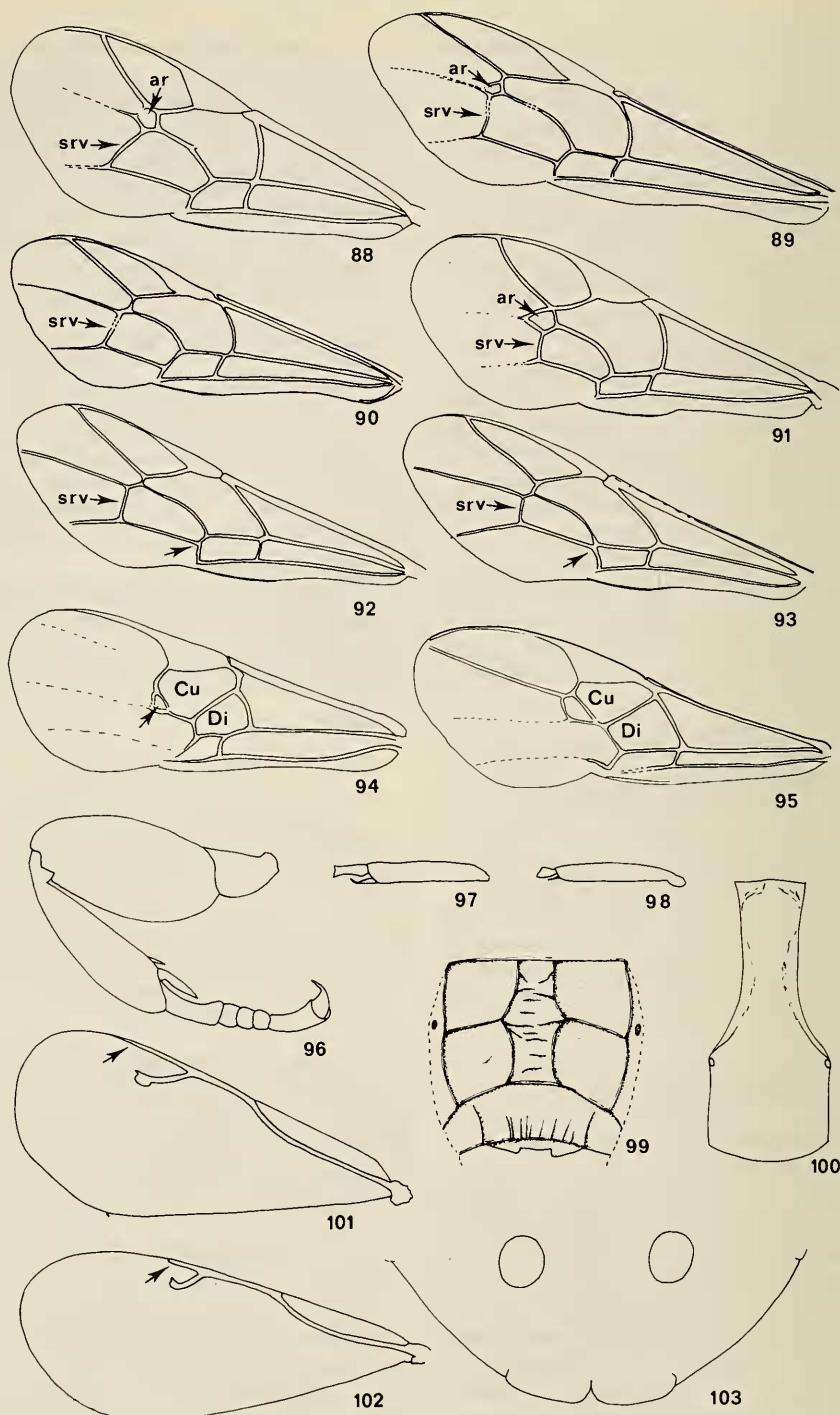
We reared two specimens, both from caterpillars of *Adoxophyes orana*. Askew (1968) mentions it a quite common parasite, especially of Tortricidae and Gracilariidae.

Adults: 30 August and 4 October.

Colpoclypeus florus (Walker)

(figs. 98, 103)

This is no doubt the most important parasite of *Adoxophyes orana* in apple orchards. We reared it in large numbers in some orchards during late summer and early autumn. There seems to be a serious discrepancy between the phenology of the parasite and of *Adoxophyes orana*, as we were not able to recover the parasite before



Figs. 88—95. Fore wing: 88, *Lysibia nana*; 89, *Telentaeta striata*; 90, *Glypta varicoxa*; 91, *Mesochorus* sp.; 92, *Habronyx canaliculatus*; 93, *Agrypon anxium*; 94, *Lissogaster* sp.; 95, *Meteorus ictericus*. Fig. 96. *Triclistus palipes*, fore leg. Figs. 97—98. Fore tibia: 97, *Dibrachys cavus*; 98, *Colpoclypeus florus*. Fig. 99. *Apophua cicatricosa*, propodeum. Fig. 100. *Diadegma* sp., first tergite. Figs. 101—102. Fore wing: 101, *Habroclytus chrysos*; 102, *Dibrachys cavus*. Fig. 103. *Colpoclypeus florus*, front margin of clypeus.

July (Evenhuis, 1974b). During and after this month its population increases rapidly. The discrepancy makes the feasibility of the parasite in integrated control doubtful. In spite of efforts in later years, we could not find any alternative leafroller host on which it could maintain itself and reproduce, neither in apple orchards, nor outside on other foodplants than apple. Thus the problem remains unsolved. More knowledge of the bionomics and ecological particularities of the parasite seems a prerequisite in using it in integrated control in apple growing.

Adults: From the end of July until October.

It is interesting that in Swiss material, kindly sent to us by Dr. A. Schmid, Nyon, Switzerland, four additional species of parasitic Hymenoptera, reared from apple leafrollers, but only in small numbers, are represented: *Sympiesis acalle* (Walker) from *Adoxophyes orana*, *Dicladocerus westwoodii* Westwood from *Archips* sp., *Euderus albitarsis* Zetterstedt, and *Goniozus claripennis* Förster, both from *Adoxophyes orana*. The three former species are Chalcidoidea Eulophidae, the latter belongs to the Bethyliidae.

KEY TO THE ADULT PARASITES OF APPLE LEAFROLLERS IN THE NETHERLANDS

The characters used in this key are simple. Differences between the taxa only refer to species that are dealt with in the body of the paper. Where species identification is very doubtful, the key generally does not run to species level, especially when the species are no important apple leafroller parasites.

1. Fore wings with longitudinal veins and cross veins, delimiting several cells (cf. figs. 88—95); (Ichneumonidae) 2
- Venation of fore wing strongly reduced (figs. 101, 102). Small species with metallic green or blue body; (Chalcidoidea) 44
2. Second recurrent vein present (figs. 88—93: srv); first cubital cell and discoidal cell fused (figs. 88—93). Second and third gaster segments separated (cf. figs. 3, 14, 15, 34, 36); (Ichneumonidae) 3
- Second recurrent vein lacking; first cubital cell (Cu) and discoidal cell (Di) separated by a vein (figs. 94, 95). Second and third gaster segments fused (cf. figs. 62, 63, 65, 66, 75, 78, 87); suture, however, generally visible; (Braconidae) 25
3. Gaster depressed, petiole broadly attached to propodeum (cf. figs. 14, 15) 4
- Gaster compressed, petiole proximally slender (cf. figs. 30, 32, 100) 18
4. Tergites 2, 3 and 4 with oblique furrows (cf. figs. 14, 15) 5
- Tergites 2, 3 and 4 without furrows (cf. figs. 3, 34, 36) 9
5. Areolet present (fig. 89: ar). Species gay-coloured black and yellow *Telentaea striata*
- Areolet absent (fig. 90). Yellow markings less conspicuous 6
6. Frontal tibial spur reaching to middle of first tarsal segment or beyond (fig. 19) ... 7
- Frontal tibial spur not reaching to middle of first tarsal segment (figs. 23, 27). Genal carina not strongly sinuated (fig. 25) *Glypta varicoxa*
7. Genal carina strongly sinuated (fig. 21); clypeus with small incision (fig. 20) *Glypta nigrina*
- Genal carina moderately sinuated (fig. 17); clypeus without incision (fig. 16) 8
8. Propodeal carinae strongly developed (fig. 99) *Apophua cicatricosa*
- Propodeal carinae more or less obliterated *Apophua* sp.
9. Clypeus and face conspicuously strongly convex (figs. 33, 35). Legs, especially femora, conspicuously stout (fig. 96) 10
- Clypeus and face not convex. Legs rather slender 12
10. Antennal sockets separated by a high lamella, the latter with a deep median groove dorsally, just below ocellus 11
- Antennal sockets not separated by a lamella *Exochus* spp.
11. Tergites almost completely pubescent (fig. 36) *Triclistus globulipes*
- Tergites almost completely glabrous. (fig. 34) *Triclistus pallipes*
12. Inner orbits at the level of the antennal sockets deeply incised (figs. 5, 7, 8) 13
- Inner orbits not or weakly incised (fig. 1) 15
13. Head of male with yellow markings. Ovipositor curved downwards (fig. 9) *Apechthis* spp.
- Head of male black. Ovipositor straight (fig. 4) 14
14. Head beneath antennae and centre of mesoscutum finely punctate (fig. 5). Tergites wholly black *Itoplectis alternans*
- Head beneath antennae and centre of mesoscutum roughly punctate (fig. 7). Hind bor-

- der of tergites brownish *Itopectis maculator*
15. Clypeus incised (fig. 1). Tergites roughly punctate except for narrow hind strip which is finely transversely striated (fig. 3) *Scambus brevicornis*
- Clypeus not incised. Tergites not roughly punctate 16
16. Areolet more or less regularly pentagonal, sometimes outer crossvein lacking (fig. 88) *Cryptinae*
- Areolet not pentagonal 17
17. Claws pectinate (fig. 10). Scutellum, post-scutellum and propodeum with yellow markings *Phytodietus segmentator*
- Claws simple. Scutellum, postscutellum and propodeum entirely black *Lissonota complicator*
18. Areolet large, rhombical (fig. 91) *Mesochorus* sp.
- Areolet small or absent 19
19. Body conspicuously slender. First gaster segment long and narrow, but not petiolated anteriorly, following segments strongly compressed 20
- Body not conspicuously slender. First gaster segment petiolated anteriorly (fig. 100), following segments compressed 21
20. Postnervulus intercepted near or below middle (fig. 92: arrow) *Habronyx canaliculatus*
- Postnervulus intercepted distinctly above middle (fig. 93: arrow) ... *Agrypon anxium*
21. Pronotum moderately to strongly striated; central part of propodeum excavated and transversely striated *Campoplex* spp.
- Pronotum rather smooth or punctate; central part of propodeum flattened or a little convex 22
22. Hind tibia light brown, just like most of the legs 23
- Hind tibia whitish, with dark ring proximally and distally 24
23. Areolet present *Tranosema arenicola*
- Areolet absent *Diadegma apostata*
24. Second tergite about as long as wide *Diadegma praerogator*
- Second tergite much longer than wide *Diadegma fenestralis*
25. Gaster segments fused into a carapace without sutures, oval, roughly sculptured ... 26
- Only second and third gaster segments fused, sutures visible (figs. 62, 63, 65, 66, 75, 78) 27
26. Clypeus with two small incisions (fig. 70). Hind border of propodeum with two lateral spinal processes only (fig. 72). Legs largely rufous *Ascogaster rufidens*
- Clypeus entire (fig. 67). Hind border of propodeum except for lateral spines also with two medial spinal processes (fig. 69) ... *Ascogaster quadridentata*
27. Radial cell distinctly defined and narrow (fig. 64) 28
- Radial cell not narrow 29
28. First and second tergites longitudinally striated, in the female also third tergite partially striated (figs. 65, 66) ... *Agathis rufipes*
- Only first tergite longitudinally striated (figs. 62, 63) *Agathis dimidiator*
29. Some veins, e.g. radial vein, pale and hardly visible, distinctly different from the other veins (fig. 46) 30
- At least radial vein well-developed 37
30. Second cubital cell present, small (fig. 94) ... *Lissogaster* spp.
- Second cubital cell absent (fig. 46) 31
31. Pterostigma hyaline (figs. 46, 47), borders slightly darkened 32
- Pterostigma dark, sometimes with light basal spot (figs. 48—52) 33
32. Pronotal groove deep and crenulated over its whole length (fig. 39); propodeum with two carinae, constituting a V, space between rather smooth (fig. 53). First tergite narrowed apically *Apanteles ater*
- Pronotal groove superficial, slightly crenulated in caudal half (fig. 40); propodeum with median, longitudinal, rather roughly sculptured trough (fig. 54). Side borders of first tergite more or less parallel *Apanteles xanthostigma*
33. Pterostigma with light proximal spot (figs. 49, 51) 34
- Pterostigma without light proximal spot (figs. 48, 50, 52) 35
34. Propodeum strongly punctate reticulate (fig. 58) *Dolichogenidea dilecta*
- Propodeum smooth (fig. 56) *Dolichogenidea laevigata*
35. Middle hind part of propodeum excavated, crenulated in its caudal end (figs. 57, 59) ... 36
- Propodeum almost entirely smooth, with a few superficial wrinkles in the middle hind part (fig. 55) *Dolichogenidea sicaria*
36. Rim near hind side of pronotum distinct (fig. 45). Pterostigma entirely dark (fig. 52) *Dolichogenidea longicaudus*
- Pronotal rim only superficial (fig. 43).

- Centre of pterostigma somewhat lighter (fig. 50) *Dolichogenidea corvina*
37. Second tergite at least as long as wide ... 38
— Second tergite distinctly wider than long 41
38. Mesoscutum divided into three vaulted lobes, the middle the highest (fig. 83) ... 39
— Mesoscutum more or less flat, not divided *Charmon cruentatus*
39. Pterostigma almost colourless (fig. 84)
..... *Macrocentrus thoracicus*
- Pterostigma dark, proximally somewhat lighter 40
40. Body predominantly rufous
..... *Macrocentrus linearis*
- Body predominantly black
..... *Macrocentrus pallipes*
41. First gastral segment narrow proximally, with two deep pits (dorsope) in front of the middle (fig. 75) *Meteorus ictericus*
- First gastral segment broadly inserted to propodeum, without deep dorsope (fig. 78) 42
..... *Oncophanes minutus*
- Propodeum without delimited areas (fig. 80) 43
43. Mesoscutum densely pilose (fig. 79)
..... *Bracon* sp.
- Mesoscutum less pilose, hind part almost bare *Bracon obscurator*
44. Fore tibiae with large, curved spur (fig. 97) 45
.....
- Fore tibiae with short, straight spur (fig. 98) 46
45. Postmarginal vein as long as stigmal vein (fig. 102: arrow) *Dibrachys cavus*
- Postmarginal vein longer than stigmal vein (fig. 101: arrow) *Habrocytus* spp.
46. Anterior margin of clypeus medially narrowly incised (fig. 103) *Colpoclypeus florus*
- Clypeus not incised 47
47. Propodeum with carinae
..... *Pnigalio pectinicornis*
- Propodeum without carinae
..... *Sympiesis xanthostoma*

DISCUSSION

Among the Hymenopterous parasites, associated with apple leafrollers, some species were reared commonly and in rather large numbers, whereas most of them were only obtained occasionally. Many of these latter are no rare species

whatever, but do not really belong to the apple orchard community (table 1).

In provisional investigations parasites were also reared by collecting leafroller caterpillars on other foodplants and in different habitats. Many of these parasites belong to other species than those from apple orchards or to the same species but in entirely different ratios. The same feature holds also for some leafroller species, e.g., *Adoxophyes orana* was only found occasionally outside apple orchards. If these investigations might prove to have a general bearing, it could mean that leafroller caterpillars in habitats adjoining apple orchards, only play a minor role as a reservoir for apple leafroller parasites. It must be born in mind that there are several types of apple orchards, with different ecological conditions to satisfy the needs of the several parasite species. As an example of the special needs of a leafroller parasite might be mentioned Zwölfer's remark concerning *Apanteles xanthostigma*, the female of which only looks for its hosts in the shrubs and the lowermost parts of the trees (Zwölfer, 1962). Such ecological preferences might at least partly explain the scarcity in apple orchards of so many parasite species that are quite common elsewhere.

It is obvious that numerous investigations are still necessary for obtaining a more clear insight in the intricate interrelationships between the different leafroller species on apple and their parasites. By rearing parasites from known hosts, large series of parasites belonging to one species, may be obtained. Rearing not only gives information about host specificity of the parasite, but also may be of interest in understanding species variation.

It does not seem superfluous to emphasize the tremendous importance of a sound taxonomical base in distinguishing the species. From our investigations it may be concluded that for most groups of Hymenopterous leafroller parasites this base is not present and this might apply as well to the group of parasitic Hymenoptera as a whole.

Parasitic Hymenoptera constitute an insect group very rich in species. We estimate that Dutch species far outnumber 7000, the total number of insect species in the Netherlands probably not exceeding 25,000. We do not venture to give figures for larger areas, but we suppose that parasitic Hymenoptera are extraordinarily numerous throughout the world. Large genera with quite similar species are no excep-

Table 1. Enumeration of parasitic Hymenoptera with the numbers that were reared from their apple leafroller hosts.

	<i>Pandemis cerasana</i>	<i>Pandemis heparyana</i>	<i>Archips rosana</i>	<i>Archips podana</i>	<i>Archips xylosteana</i>	<i>Clepsis spectrana</i>	<i>Adoxophyes orana</i>	<i>Ptycholoma lecheana</i>	<i>Acleris</i> spp./ <i>Croesia holmiana</i>	<i>Spilonota ocellana</i>	<i>Rhopobota naevana</i>	<i>Hedya nubiferana</i>	Host unknown
<i>Scambus brevicornis</i>		1		2		87							7
<i>Itoplectis alternans</i>		2	1	2		29		2		1			11
<i>Itoplectis maculator</i>		1	4			3						3	1
<i>Apechthis compunctor</i>												1	
<i>Apechthis quadridentatus</i>		1											
<i>Apechthis rufatus</i>				1				1					
<i>Phytodietus segmentator</i>			6	5									
<i>Gelis</i> spp.			2				1			1			
<i>Acrolyta</i> sp.										1			
<i>Lysibia nana</i>		3											
<i>Teleutaea striata</i>	1	3				65	7						2
<i>Apophua cicatricosa</i>	1	6											
<i>Apophua</i> sp.				1									
<i>Glypta nigrina</i>						2	2						
<i>Glypta varicoxa</i>										20			
<i>Lissonota complicator</i>				22									4
<i>Diadegma praerogator</i>	2	4	5	1		19	9	2	9			7	2
<i>Diadegma apostata</i>								1				1	
<i>Diadegma fenestralis</i>			1										
<i>Tranosema arenicola</i>	1	6	22	2		1			3				2
<i>Campoplex difformis</i>	1					1			3				
<i>Campoplex</i> sp.										5			1
<i>Campoplex</i> spp.		2		4		2	2	3					
<i>Mesochorus silvarum</i>	1					1							
<i>Stictopisthus lineatus</i>						1							1
<i>Triclistus pallipes</i>											10		
<i>Triclistus globulipes</i>				2	1								
<i>Exochus</i> sp. 1									1				
<i>Exochus</i> sp. 2						1							
<i>Habronyx canaliculatus</i>			2										
<i>Agrypon anxium</i>									3	1			
<i>Apanteles ater</i>		24		43		12	2	6					8
<i>Apanteles xanthostigma</i>		26	8			38	2		14			12	7
<i>Dolichogenidea laevigata</i>									1				
<i>Dolichogenidea dilecta</i>													1
<i>Dolichogenidea longicaudus</i>									1			2	
<i>Dolichogenidea corvina</i>						1			1				1
<i>Dolichogenidea sicaria</i>			1			1			1			1	
<i>Lissogaster</i> spp.		1	6			1		2					2
<i>Agathis dimidiator</i>										27			1
<i>Agathis rufipes</i>										30			2
<i>Ascogaster quadridentata</i>										24		5	5
<i>Ascogaster rufidens</i>	13	28	1			6							3
<i>Meteorus ictericus</i>	2	6	4	4		24			19		1		12
<i>Oncophanes minutus</i>		1				10							
<i>Bracon</i> sp.						1							
<i>Bracon obscurator</i>										1			
<i>Macrocentrus linearis</i>	13	113		19									1
<i>Macrocentrus pallipes</i>												1	
<i>Macrocentrus thoracicus</i>										1			
<i>Charmon cruentatus</i>									1				
<i>Habrocytus chrysos</i>						3							
<i>Habrocytus semotus</i>				1		2							
<i>Dibrachys cavius</i>		1		1									1
<i>Prigalis pectinicornis</i>						1					1		
<i>Sympiesis xanthostoma</i>						2							
<i>Colpoclypeus florus</i>		3				248							3

tion in this group. Thus it is hardly surprising that identification meets with very large difficulties. Yet, exact species discrimination seems essential, as very similar species show considerable differences in biological and ecological respects.

Descriptions of species by the earlier taxonomists are generally too poor to allow of any conclusion about their identity. They often suit more than one species. Later authors, who tried to interpret them in their own way, added new species, just as ill-described. In this way taxonomic literature has been overburdened with "species" from which no one can establish their identity to-day.

In the past a number of taxonomic works have been written, dealing with larger groups of parasitic Hymenoptera and based mainly on a compilation of these insufficiently described species, which were often not fully understood by the compilers themselves. Some examples of these works are Schmiedeknecht's *Opuscula Ichneumonologica* (1902—1936), Fahringer's *Opuscula Braconologica* (1928—1937), Kieffer's work in "Das Tierreich" on Proctotrupoidea (1914—1926) and that of Dalla Torre & Kieffer on Cynipoidea (1910), also in "Das Tierreich". It is not our intention to criticize these works. They present excellent surveys of the knowledge of the several species at that time, and any specialist who occupies himself with these groups now, has to consult them. However, they do not satisfy the needs of a modern entomologist who wants to know the reliable names and taxonomical status of the species which he encounters in his ecological investigations. Unreliable species names of parasitic Hymenoptera show up in reviewing journals, e.g., *The Review of Applied Entomology*, and from these they are compiled in comprehensive works like Thompson's host-parasite lists.

In view of the difficulties discussed above, it cannot be expected that the gap in our taxonomic knowledge of the species of parasitic Hymenoptera will be filled up within a reasonable time. Fortunately in the last decades an increasing interest in the taxonomy of parasitic Hymenoptera has arisen, and many groups have now been or will soon be revised.

Ecologists have to rely on identifications by specialists. Only these specialists are thoroughly acquainted with the taxonomic difficulties and their nomenclatorial consequences. Only a spe-

cialist in a certain not too large taxonomic group can really judge in how far his identifications are reliable.

It might be desirable that a specialist, in identifying material on behalf of ecological investigations, should add some more information than merely the name. The ecologist should also be informed about the reliability of the species name, which can only be judged by the specialist.

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REFERENCES

- Achterberg, C. van, 1974. The features of the petiolar segment in some Braconidae. — *Ent. Ber.*, Amst. 34: 213—214.
- , 1976. A preliminary key to the subfamilies of the Braconidae (Hymenoptera). — *Tijdschr. Ent.* 119: 33—78.
- , 1982. Familietabel van de Hymenoptera in Noordwest Europa. — *Wet. Meded. K. Ned. natuurh. Veren.* 152: 1—50.
- Aeschlimann, J. P., 1973. Révision des espèces ouest-paléarctiques du genre *Triclistus* Foerster (Hymenoptera: Ichneumonidae). — *Mitt. Schweiz. ent. Ges.* 46: 219—252.
- Ankersmit, G. W., 1968. The photoperiod as a control agent against *Adoxophyes reticulana* (Lepidoptera; Tortricidae). — *Entomologia exp. appl.* 11: 231—240.

- Askew, R. R., 1968. Hymenoptera Chalcidoidea, Elasmidae and Eulophidae (Elachertinae, Eulophinae, Euderinae). — Handbks Identif. Br. Insects 8 (2b): 1—39.
- Aubert, J. T., 1978. Les Ichneumonides ouest-paléarctiques et leurs hôtes 2. Banchinae et suppl. au Pimplinae. — ÉDIFAT-OPIDA, Echauffour: 1—318.
- Auersch, O., 1960. Weitere Beobachtungen zum Auftreten des Fruchtschalenwicklers (Apfelschalenwicklers) *Adoxophyes reticulana* Hb. — Anz. Schädlingsk. 33: 83—87.
- Bentinck, G. A. Graaf, & A. Diakonoff, 1968. De Nederlandse bladrollers (Tortricidae). — Monogr. Ned. ent. Veren. 3: 1—200.
- Betz, E., & F. Schwerdtfeger, 1970. Lepidopteren-Parasiten aus zwei nordwest-deutschen Eichenwäldern. — Entomophaga 15: 347—351.
- Bogenschütz, H., 1965. Untersuchungen über Parasiten des Eichenwicklers *Tortrix viridana* L. II. Bestimmungstabellen der Larven und Puppen einiger an Eichen lebender Tortriciden als Hilfsmittel bei Parasitenzuchten. — Entomophaga 10: 67—72.
- Bradley, J. D., W. G. Tremewan & A. Smith, 1973. British Tortricoid Moths. Cochylidae and Tortricidae: Tortricinae. — Ray Soc., Lond. 147: 1—251.
- Carl, K. P., 1974. Observations sur les parasites de Capua. — Les organismes auxiliaires en verger de pommiers OILB/SROP, Brochure 3: 49—52.
- Charles, P. J., 1974. Le complexe de parasites et de prédateurs des tordeuses autres que le Carpocapse et le Capua. — Les organismes auxiliaires en verger de pommiers OILB/SROP, Brochure 3: 39—47.
- Couturier, G., 1973. Étude éthologique et biocoenotique du peuplement d'insectes dans un verger "naturel". — Trav. Docums. O.R.S.T.O.M. 22: 1—96.
- Cox, J. A., 1932. *Ascogaster carpocapsae* Viereck, an important larval parasite of the codling moth and oriental fruit moth. — Bull. N. Y. St. agric. Expn. Stn. 188: 1—26.
- Eady, R. D., & J. A. J. Clark, 1964. A revision of the genus *Macrocentrus* Curtis (Hym. Braconidae) in Europe, with descriptions of four new species. — Entomologist's Gaz. 15: 97—127.
- Evenhuis, H. H., 1969. Two *Ascogaster* species (Hymenoptera, Braconidae), parasites of leafrollers (Lepidoptera, Tortricidae) in apple orchards, with different host selection. — Ent. Ber., Amst. 29: 159—160.
- , 1974a. Les ennemies des tordeuses du pommier. — Les organismes auxiliaires en verger de pommiers OILB/SROP, Brochure 3: 29—30.
- , 1974b. Les Hyménoptères parasites des tordeuses nuisibles aux vergers de pommiers aux Pays-Bas. — Les organismes auxiliaires en verger de pommiers OILB/SROP, Brochure 3: 53—59.
- Evenhuis, H. H., & H. J. Vlugg, 1972. Morphologische Unterschiede zwischen den Mandibeln der am Apfel lebenden Raupen der Blattwicklerarten. — Z. angew. Ent. 71: 152—155.
- , 1973. Over twee *Apanteles*-soorten (Hymenoptera, Braconidae) als parasieten van bladrollers (Lepidoptera, Tortricidae) van appel. — Ent. Ber., Amst. 33: 86—90.
- Evenhuis, H. H., D. J. de Jong & H. J. Vlugg, 1973. Die Puppen der in den Niederlanden am Apfel vorkommenden Blattwickler (Lepidoptera, Tortricidae). — Z. angew. Ent. 73: 351—365.
- Fahringer, J., 1934. Opuscula braconologica. Palaearktische Region III, Braconinae (Cyclostomi Aut.), Cheloninae (Cryptogastres Aut.). — Wien, Verlag Fritz Wagner: 1—594.
- Fischer, M., 1970. Die *Meteorus*-Arten des Burgenlandes (Hymenoptera, Braconidae, Euphorinae). — Wiss. Arb. Burgenld 44: 254—300.
- Fitton, M. G., et al., 1978. A check list of British Insects Hymenoptera. In: Kloet & Hincks. — Handbks Identif. Br. Insects 11 (4): i-ix + 1—159.
- Gauld, I. D., & P. A. Mitchell, 1977. Ichneumonidae Orthopelmatinae & Anomaloniinae. — Handbks Identif. Br. Insects 7 (2b): 1—32.
- Graham, M. W. R. de V., 1969. The Pteromalidae of Northwestern Europe (Hymenoptera: Chalcidoidea). — Bull. Br. Mus. nat. Hist., Entomology, Supplement 16: 1—908.
- Hannemann, H. J., 1961. Kleinschmetterlinge oder Microlepidoptera I. Die Wickler (s. str.) (Tortricidae). — Tierwelt Dtl. 48: 1—223.
- Herting, B., 1965. Die Parasiten der in Nordwestdeutschland an Obstbäumen und Laubholz schädlich auftretenden Spanner- und Eulenraupen (Lep.: Geometridae, Noctuidae, Thyatiridae). — Z. angew. Ent. 55: 236—263.
- Horstmann, K., 1969. Typenrevision der europäischen Arten der Gattung *Diadegma* Förster (syn. *Angitia* Holmgren). — Beitr. Ent. 19: 413—472.
- , 1971. Untersuchungen über die Parasiten der an Eichen lebenden Tortriciden während einer Massenvermehrung des grünen Eichenwicklers (*Tortrix viridana* L.). — Waldhygiene 8: 226—242.
- , 1973. Nachtrag zur Revision der europäischen *Diadegma*-Arten. — Beitr. Ent. 23: 131—150.
- Huddleston, T., 1980. A revision of the western Palearctic species of the genus *Meteorus* (Hym.: Braconidae). — Bull. Br. Mus. nat. Hist. (Entomology) 41 (1): 1—58, figs. 1—58.
- Janssen, M., 1958. Über Biologie, Massenwechsel und Bekämpfung von *Adoxophyes orana* Fischer von Roeslerstamm. — Beitr. Ent. 8: 291—324.
- Jong, D. J. de, & H. J. Vlugg, 1974. Clef d'identification des chenilles des tordeuses du pommier aux Pays-Bas. — Les organismes auxiliaires en verger de pommiers OILB/SROP, Brochure 3: 35—37.
- Kasparyan, D. R., 1973. A review of the palaearctic Ichneumonids of the tribe Pimplini (Hymenoptera, Ichneumonidae). The genera *Itopectis* Först. and *Apechthis* Först. — Ent. Obozr. 52:

- 665—681 [Russian, with English summary; complete translation in English in: Ent. Rev. 52: 444—455].
- Lehmann, W., 1969. Beitrag zur Kenntnis der Tortricidenfauna an Apfelbäumen und ihrer Parasiten. — NachrBl. dt Pfl Schutzdienst, Berl. 23: 83—86.
- Mason, W. R. M., 1981. The polyphyletic nature of *Apanteles* Förster (Hymenoptera: Braconidae): A phylogeny and reclassification of Microgasterinae. — Mem. ent. Soc. Can. 115: 1—147.
- Matthey, W., 1967. The natural history of three oak-feeding Tortricids: *Ptycholoma lecheana* (L.), *Pandemis cerasana* (Hb.) and *Batodes angustiorana* (Haw.). — Entomologist 100: 315—320.
- Miczulski, B. & M. Košlinska, 1976. Parasites of the leafrollers (Tortricidae) occurring in apple orchards in some regions of Poland. [Polish, with English summary.] — Polski Pismo ent. 46: 165—178.
- Nixon, G. E. J., 1965. A reclassification of the tribe Microgasterini (Hymenoptera, Braconidae). — Bull. Br. Mus. nat. Hist., Entomology, Supplement 2: 3—284.
- , 1972. A revision of the north-western European species of the *laevigatus*-group of *Apanteles* Förster (Hymenoptera, Braconidae). — Bull. ent. Res. 61: 701—743.
- , 1973. A revision of the north-western European species of the *vitripennis*, *pallipes*, *octonarius*, *triangulator*, *fraternus*, *formosus*, *parasitellae*, *metacarpalis* and *circumscripatus*-groups of *Apanteles* Förster (Hymenoptera, Braconidae). — Bull. ent. Res. 63: 169—228.
- , 1974. A revision of the north-western European species of the *glomeratus*-group of *Apanteles* Förster (Hymenoptera, Braconidae). — Bull. ent. Res. 64: 453—524.
- , 1976. A revision of the north-western European species of the *merula*, *lacteus*, *vipio*, *ultor*, *ater*, *butalidis*, *popularis*, *carbonarius* and *validus*-groups of *Apanteles* Förster (Hymenoptera, Braconidae). — Bull. ent. Res. 65: 687—735.
- Oehlke, J., 1965. Die in europäischen Kiefernbuschhornblattwespen (Diprionidae) parasitierenden Ichneumonidae. — Beitr. Ent. 15: 791—879.
- Papp, J. und G. Reichart, 1973. Angaben zur Kenntnis der Brackwespenparasiten einiger in Obstbäume schädlichen Motten (Lepidoptera et Hymenoptera). [Hungarian with German summary.] — Folia ent. hung. 26: 363—371.
- Peck, O., 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). — Can. Ent., Suppl. 30: 1—1092.
- Perkins, J. F., 1941. A synopsis of the British Pimplini, with notes on the synonymy of the European species (Hymenoptera, Ichneumonidae). — Trans. R. ent. Soc. Lond. 91: 637—659.
- , 1957. Notes on some Eurasian "*Itoplectis*", with descriptions of new species (Hym., Ichneumonidae). — Mitt. schweiz. ent. Ges. 30: 323—326.
- , 1959. Hymenoptera, Ichneumonoidea Ichneumonidae, key to subfamilies and Ichneumoninae I. — Handbks Identif. Br. Insects 7 (2a1): 1—116.
- Schmiedeknecht, O., 1914. Die Ichneumonidengattung *Pimpla*. — Z. angew. Ent. 1: 396—478.
- Swatschek, B., 1958. Die Larvalsystematik der Wickler (Tortricidae und Carposinidae). — Akademie-Verlag, Berlin: 1—269.
- Telenga, N. A., 1955. Braconidae (Microgasterinae and Agathinae). — Fauna SSSR 5 (4). (Russian, English translation: Israel Program for scientific Translations, Jerusalem, 1964).
- Townes, H., 1969. The genera of Ichneumonidae, 1. — Mem. Am. ent. Inst. 11: 1—300.
- , 1970. Id., 2. — Mem. Am. ent. Inst. 12: 1—537.
- , 1970. Id., 3. — Mem. Am. ent. Inst. 13: 1—307.
- , 1971. Id., 4. — Mem. Am. ent. Inst. 17: 1—372.
- Wilkinson, D. S., 1945. Description of palaearctic species of *Apanteles* (Hym. Braconidae). — Trans. R. ent. Soc. Lond. 95: 35—226.
- Zwölfer, H., 1962. Die Orientierung entomophager Parasiten als Problem der angewandten Entomologie. — Z. angew. Ent. 50: 93—98.